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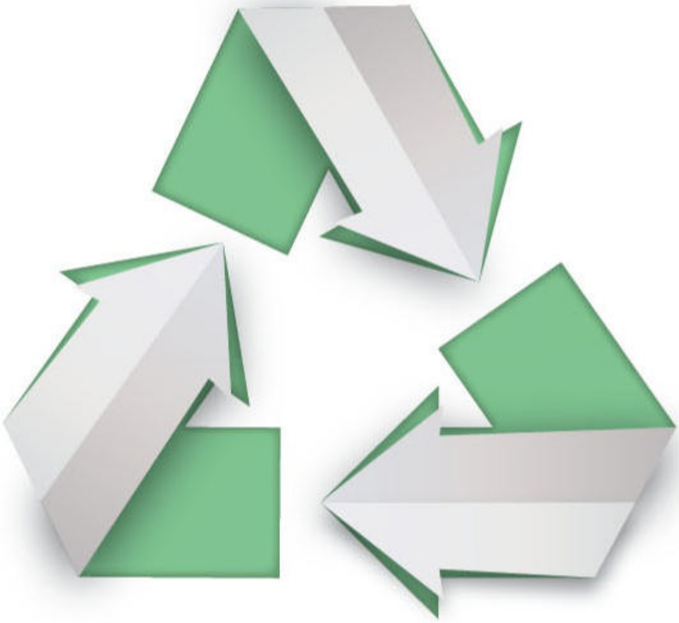

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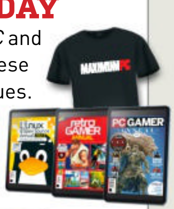

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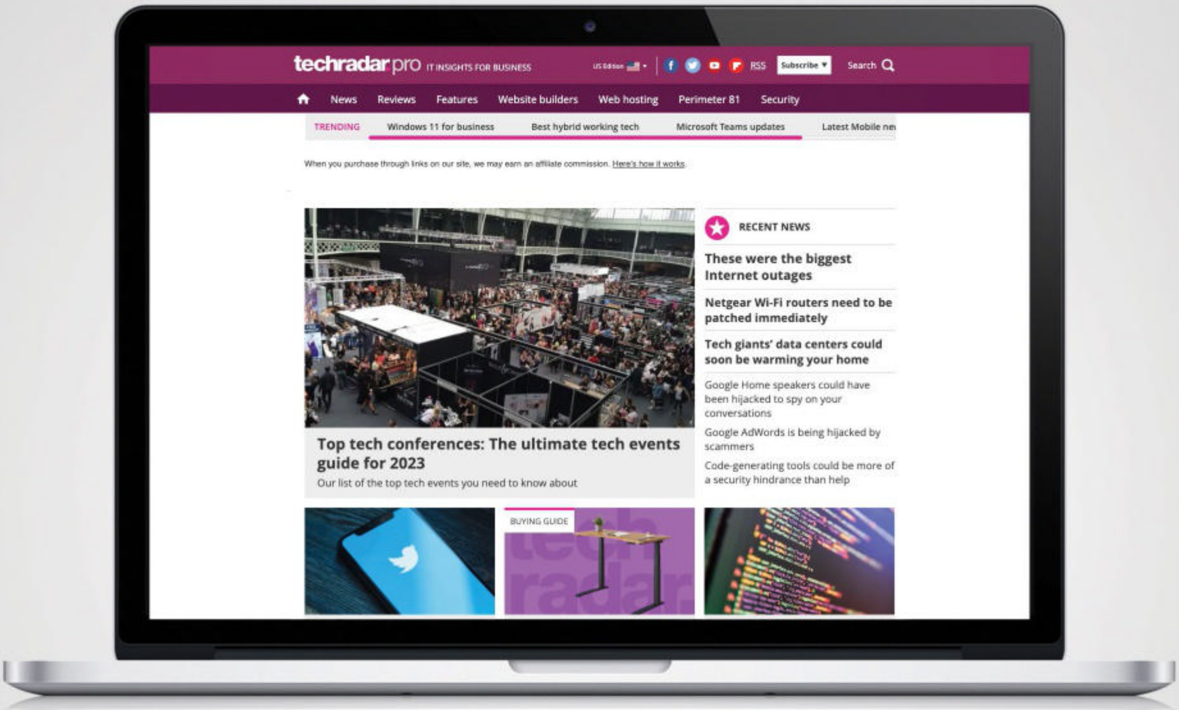
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Guy
Cocker

ALL-OUT AMD

IN THIS ISSUE OF MAXIMUM PC, we make a return to building a PC that's more in keeping with our title, going all-out with a top-of-the-line AMD gaming CPU and Nvidia's fastest GPU. Yes, while it's a fun challenge to build a sub-$1,000 gaming PC like we did last issue, as our title suggests, we're most at home when we're pushing the extremes of what PC tech can do, which is why we were keen to incorporate AMD's latest top-end 3D V-Cache chip, the Ryzen 9 7950X3D. Can AMD's extra vertically stacked cache help unlock best-ever gaming performance when paired with an RTX 4090? Or does Intel's Core i9-13900K, $150 cheaper but now six months old, still hold the crown? Sam's cover build on page 16 holds all the answers.

On the subject of AMD's 3D V-Cache offerings, if you're a gamer, I urge you to head to page 74 to read all about the Ryzen 7 7800X3D CPU. It's $250 cheaper than the chip used in our cover build, but it's unbelievably potent when it comes to gaming performance. Sure, it's not the best all-round chip available, but if all you care about is gaming performance, then it's the chip to get. The even better news is that we're already starting to see the CPU discounted, which is great news for those who want performance on a budget. AMD might be struggling slightly at the top-end against Intel, but at the mid-range, it's on to a winner.

Speaking about discounts, it seems the tide is turning against Nvidia and the astronomical pricing of its latest generation Lovelace cards, with retailers discounting cards below RRP for the first time all the way up to its flagship RTX 4090. It seems that those with the cash to hoover them up at launch, and those who aren't prepared to pay through the nose, are holding off (see news on page 9). This is even affecting the new RTX 4070, which has sold so poorly at launch, it was discounted almost immediately. This is troubling for Nvidia, who like to shout about their profitable X090 models, but know that most people wait for the X070 or X060 editions. Nevertheless, we like the RTX 4070 (reviewed on page 80), especially its ability to unlock Frame Generation in compatible games. For the right price, it's still worth paying attention to, and we hope to do a cover build very shortly where we can spec-up a mid-range machine that might be suitable for the masses.

GPU pricing is something Jeremy Laird has been writing about in his Trade Chat column for months, and he dives into the causes and what needs to change in his feature on page 42. Our resident doctor, Nick Peers, also shows us what you need to access and stream all of your favorite media around the home and remotely on page 32. While most of us are happy to pay for streaming services for everything from music to video to games, Nick shows us that you don't need to be paying through the nose for a vast array of services. For those who are reading more and more about AI, we show you how to dabble with it yourself on a local PC, with Ian Evenden's feature on how to run Stable Diffusion at home on page 50.

We also have lots of feedback on our move to digital, so thanks to all of you who got in touch. Remember, Sam and I talk about the story of the build each issue, so check that out for our gaming powerhouse PC on page 16.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's Editor-in-Chief. He built his first gaming PC in 1997 to play Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Phoenix and Meteor Lake coming

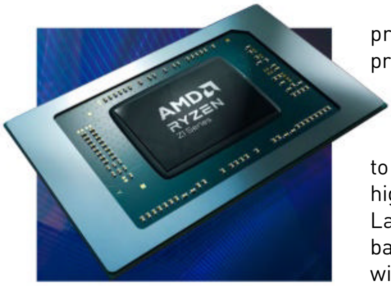
New generations of chips from AMD and Intel on the way

WE WERE PROMISED AMD's 7040-series Phoenix chips for April back when AMD revealed its new Zen 4 APUs. Then there were delays, and it's only now that we are actually getting to see what they can do.

The wait has been worth it, as these mobile chips can rival desktop processors in performance. They are the first mobile Ryzens with Zen 4 architecture, coupled to Radeon RDNA 3 graphics. They also sport a dedicated AI block, the first in any Ryzen chip. There are U versions for low-power applications on a 4nm process, and 5nm HS versions for more chunky laptops. The most powerful is the Ryzen 9 7940HS, with eight cores, a base clock of 4.0GHz, maximum boost of 5.2GHz, and an integrated 780M GPU with 12 computer cores running at 2.8GHz. The latest is the top-tier low power variant, the Ryzen 7 7840U, which is almost identical to the 7940HS, bar the clock speeds, where the base drops to 3.3GHz. A specialized version of 7040U, the Z1, and Z1 Extreme, has been designed for gaming handhelds. The first of these are the Asus ROG Ally and Aokzoe A1 Pro. First tests of a 7040-series laptop show it to be more than a match for Intel.

After the 7040-series, we will have, according to a reference document on the Phoenix APUs, AMD's first hybrid chip with performance and efficiency cores. This follows in Intel and Apple's footsteps. Intel uses two different architectures, while AMD will use the same Zen 4 design for both, only customized, most likely in the cache and frequency departments. It also makes development easier, as you only have to write to one architecture.

At Intel, we're due to see Meteor Lake, Intel's 14th generation design. It uses the Intel 4 process for the CPU tiles, which have Redwood Cove performance cores and Crestmont efficiency cores. Each brings IPC increases of between 15 to 25 percent. The top configuration so far has six performance cores and eight efficiency cores. This is Intel's first tile-based chip, with a separate processor, GPU, I/O, and SoC tiles, tied together using Foversos 3D technology, so we get multiple processes used on the same chip as the GPU, while SoC titles are manufactured by TSMC. There's a new socket, too: LGA 1851, which is the same size as LGA 1700, but with 151 extra pins.



AMD's 7040-series Phoenix chip has spawned a version for handheld gaming, the Z1.

© AMD

> First tests of a 7040-series laptop show it to be more than a match for Intel

At first, it was rumored to be mobile-only. Rather than a desktop version of Meteor Lake, we would have to make do with a refresh of Raptor Lake. Then rumors arose claiming we will get desktop versions, but only in i3 and i5 variants. Desktop versions exist, but it remains to be seen which will reach the market. The faster, higher core count desktop chips require 4nm process silicon, which is proving problematic. It's hard to tell which way Meteor Lake will go. However it ends up, it will point the way to Intel's future. Intel's next high-end desktop chip, Arrow Lake, will follow Meteor Lake's basic design and socket, but will have more power cores and new core architectures.

Meteor Lake will also bring a change in branding. Intel is to drop the Core i3/5/7/9 moniker and switch to Core Ultra. The Core i branding first appeared in 2008, when multi-core chips became the standard. Meteor Lake signals another major change, or "inflection point", as Intel's PR puts it.

Intel is going through some interesting times. In the first three months of the year, it had a revenue of $11.7 billion, 36 percent down from a year ago, resulting in a loss of $2.8 billion—the worst quarter in the company's history. Intel's chip designs may be back on top form, but the bottom line hasn't recovered. Intel says it plans to be a major player in chip production, and by 2026 rival TSMC for technology. These plans are still on track. Meteor Lake may not produce gaming monsters, but it marks the emergence of a radical new chip design that can only get better. **–CL**

TSMC TO GO 2NM BY 2025

CHIP GIANT ON TRACK WITH THREE INTERATIONS PLANNED

TSMC HAS REVEALED A FURTHER YEAR of its production roadmap at the North American Technology Symposium. N2 is on schedule for production in 2025, with two further iterations after. It brings a 10-15 percent speed improvement at the same power level, and a 25-30 percent power reduction at the same speed. Despite what the numbers suggest, chip density is 1.15 times. That metric doesn't equate directly to the size of the transistor gates, although each manufacturer measures things differently. The second-generation N2P is due in 2026, reaching customers in 2027. This uses backside power delivery (don't laugh), splitting signal and power between the front and back interconnects. This enables sizable bumps in transistor density, plus power savings. Intel is working on this too, and plans to get it running by 2025. **–CL**

RTX 4070'S PRICE PROBLEM

High pricing = low sales, it seems

IT MAY SPORT the latest GPU technology, but Nvidia's GeForce RTX 4070 isn't selling well. The Founders Edition sold out in eight hours, but after the initial rush, stock remained available, and you can now buy pretty much any other edition. According to various sources, the company is to pause production for a month to let things settle. Nvidia is also said to be considering offering card builders a $50 rebate. This lackluster demand has pushed prices down to below the recommended retail price of $599 in many places. The card is as fast as the 3080, but $100 cheaper. However, it is more expensive than the 3070 was, and customers were expecting a comparable price. It's not a bad card, but the bang-per-buck isn't balanced, especially if you're upgrading. The RTX 4060 Ti is due at an expected $449, which given the performance dip of the AD106 GPU, might be asking too much too. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

SOFT ROBOTS
Engineers at Carnegie Mellon University have developed a low-density polymer gel.

SAME KEY, NEW FUNCTION
Win11 is to make the Print Screen key act as a snipping tool by default.

MSI'S AFTERBURNER RETURNS
We've finally got a new version to play with after the employment of a Russian engineer on the GPU tweaking tool was suspended.

TRAGEDIES

HARDWARE DESTRUCTION
Cisco destroyed $23.5 million of unsold equipment deemed likely to fall into Russian hands.

CHATGPT EXPOSES SECRETS
Engineers at Samsung fed the AI bot confidential data to solve a coding problem, exposing the data to third parties.

STARSHIP GROUNDED
A test of SpaceX's Super Heavy booster produced debris, some of which may be hazardous.

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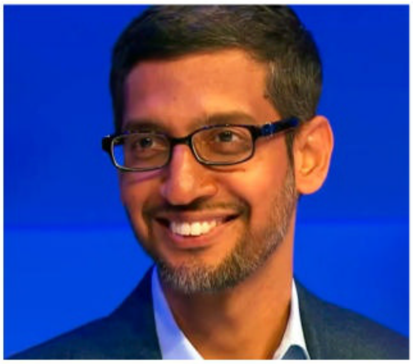

BRACE FOR IMPACT

AI developers warn: this could get bumpy

NEW TECHNOLOGIES bring dissenting voices. The explosion of AI-powered systems has brought more than its fair share of people sounding alarms. However, many of these voices belong to engineers and scientists who were involved in AI development at the highest levels, and know what they are talking about. Google's CEO, Sundar Pichai (pictured above), has delivered a sobering warning about the effects of AI-powered systems in a recent interview. It will, he says, affect "every product across every company". His biggest concern is that it can all too easily be used to spread convincing misinformation. Google has had a series of internal guidelines for AI since 2018. "We have to be very thoughtful" he warns.

A recent Netflix drama included an AI-powered 'enhanced interrogation' robot developed by the CIA. It was satire, but chilling. As scientist and psychologist Geoffrey Hinton pointed out, AI isn't intrinsically evil, but in the wrong hands it could make malice go a long way. He warns of serious societal problems if AI is used without restrictions. Early versions of ChatGPT weren't released because they were too easy to use maliciously. Google only reluctantly released Bard when Microsoft forced its hand. Nvidia is concerned enough to develop NeMo Guardrails, an open-source system designed to stop large language model AI from going too far. The implications of AI tools in the hands of organizations with little regard for individual freedoms is grim. AI does not know what is true, but is good at justifying errors. AI does not know what is harmful, but has the ability to change the world. Right now, we are in the midst of a huge experiment to see what it is capable of. It will be disruptive, and some of that disruption will be destructive. **–CL**

ACTIVISION BLIZZARD SALE BLOCKED

And Microsoft is very angry about it

MICROSOFT had spent 15 months in planning and negotiations to buy gaming giant Activision Blizzard in a $68.7 billion deal (the biggest in gaming history), but regulators have sunk the idea.

The British Competition and Markets Authority (CMA) has cited concerns over Microsoft's dominance in cloud gaming. It has a point; Microsoft currently has 60 to 70 percent of that market, and adding Activision Blizzard's titles would put it in a dominant position. Microsoft had promised to keep big titles available on other platforms beyond current contracts, but the CMA didn't think this was enough.

Microsoft is not happy. Its president, Brad Smith, called it the "darkest day in our four decades in Britain", and that "people are shocked, people are disappointed, and people's confidence in technology in the UK has been severely shaken". Activision Blizzard was equally dismissive, with a spokesperson saying, "the report's conclusions are a disservice to UK citizens", and that "global innovators large and small will take note".

It's worth noting that the company has a history of 'robust' business practices. After the purchase of Bethesda, Microsoft ensured all future games were exclusive.

You might think there would be an obvious winner: Sony. However Microsoft might try to leverage its current position to keep the big titles off the PlayStation. There is a good reason there are regulatory bodies to stop any one company from dominating a market: it isn't good for customers. Capitalism needs competition to work effectively, or it becomes something else. **–CL**

Hard drives have lasers now, in a bid to increase capacities to 100TB within the next few years.

Seagate drives reach 30TB

NOW JUST THREE MANUFACTURERS of hard drives are left, so competition is spirited. Seagate is shipping qualification samples of its new 30TB drives to its data center customers. These are the highest-capacity drives yet, beating 26TB drives from Western Digital and Toshiba. These use second generation Heat-Assisted Magnetic Recording, which uses a laser in the drive head that heats a grain (data bit) on the platter surface, enabling the recording head to flip the polarity without affecting its neighbors. HAMR requires new actuator heads and new recording media. This isn't cheap, so these drives are aimed at large-scale commercial operations using Seagate's CORVAULT systems. Of more practical interest is the new 22TB IronWolf Pro, a conventional 3.5in ten-platter SATA III drive. Officially it sells for $599, but has been seen discounted to $399, which equates to $18 per terabyte.

Meanwhile, Seagate picked-up a $300 million fine from the Department of Commerce for violation of export controls. It shipped 7.4 million hard drives to Huawei in 2020 and 2021, becoming its sole supplier. WD and Toshiba obeyed the export controls. It's estimated that the fine is about twice the profit earned. Despite the advantages of solid state, the HDD is a long way from dead, even in the desktop market, but sales aren't strong. In the first quarter of the year they were down by 35 percent over last year. Samsung plans to have 100TB HDDs by 2025, as do its rivals, so if you need serious amounts of data storage, the spinning disc is still king. **–CL**

Hot Ryzens

AMD is having more problems with its 7000X3D-series chips. Chips have been fried after being tweaked with AMD's EXPO, aka Extended Profiles for Overclocking, which AMD does endorse. This can also trigger higher voltages for the processor, aging the chip to the point of failure. After testing by independent bodies, it seems there's more: motherboards are not detecting thermal problems properly, and it's possible for a board's over-current protection to keep feeding power to a dying or dead chip, destroying the motherboard. Problems like this produce a lot of internet chatter, even if the failure rate remains small. At least AMD will replace fried chips. **–CL**

ARM to build its own

ARM will design a series of chips under its own name. The word is that this will be a serious technological push to design an innovative advanced chip following the success of the Apple M2. The design team will be led by Kevork Kechichian, who spent years on the Snapdragon. There are no plans to produce commercial quantities, but rather a series of prototypes to show what ARM is capable of. Why now though, after years of quietly working behind the scenes? Next year, the company plans an IPO, launching it onto the stock market. More buzz: a higher price. ARM hopes to get a return on its investment by showing potential investors what it is capable of. **–CL**

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Jarred Walton

TECH TALK

PCIe 5.0 SSDs Are Finally Here

THE PCI EXPRESS 5.0 specification was finalized on May 29, 2019. The first PCIe 5.0-ready consumer platform arrived with Intel's Z690 chipset and socket LGA1700 platform in November 2021. (IBM's Power10 processor was announced in 2020 and started shipping in mid-2021.) But PCIe 5.0 graphics cards and SSDs were nowhere to be found.

In fact, outside of certain Nvidia data center H100 solutions, PCIe 5.0 GPUs are still not here, but after waiting for over a year, the SSDs are starting to trickle out. The first crop of PCIe 5.0 M.2 SSDs all use Phison's E26 controller. That's an interesting point to begin with, as Phison at one point was regarded as one of the slower SSD controller options. That has changed a lot over the past several years, and the E26 now reigns as the fastest solution we've tested. It uses a dual ARM Cortex-R5 design with triple-core CoXProcessors—the coprocessors handle some common tasks, so the R5 isn't a limiting factor, even though Cortex-R8 controllers are now shipping.

Coupled with the controller is a single LPDDR4 DRAM chip. All the 2TB Phison E26 products we've looked at so far are using a 32Gb IC, or 4GB of total RAM—twice the amount we'd expect to see. Whether that's necessary to hit higher performance levels isn't clear, but we've seen the same configuration on the Crucial T700, Corsair MP700, Inland TD510, and Gigabyte Aorus Gen5 10000. But the NAND is perhaps the bigger story.

The E26 is an eight-channel controller, and it can be paired with NAND operating at up to 2400 MT/s. Everyone so far is using Micron 3D NAND with 232 layers, but no one is using the maximum 2400 MT/s speed. In fact, most of the drives are using 1600 MT/s. That's enough to go well beyond PCIe 4.0 speeds, but we're not yet maxing out the PCIe 5.0 spec. Most of the drives are rated for 10,000 MB/s reads and 9,500 (give or take), though the Crucial T700 is the exception. It has 2000 MT/s NAND and is rated for 12,400 MB/s reads and 11,800 MB/s writes.

That might sound very fast, and it is. The real-world benefits, on the other hand, aren't particularly noticeable. PCMark and 3DMark storage tests put the Gen5 drives at roughly 10–15 percent higher bandwidth than the fastest Gen4 SSDs. Copy testing was 15 percent faster as well, though the T700 was 20 percent faster than the top Gen4 drive. Only synthetic tests like Crystal Disk Mark and ATTO were able to show larger improvements. Latencies and useful random IOPS weren't significantly changed.

Even if the performance is good, there's still the power to contend with. These Gen5 SSDs all idle at around 3W of power. That's not a problem for high-end desktops, but it's not going to work with a laptop—not that any laptops currently offer PCIe 5.0 support. The higher interface speeds require more power, and PCIe 4.0 is still fast enough for all but the most demanding storage workloads.

But there's another knock-on effect: all these Gen5 drives require decent cooling. The Crucial T700 is available with a modestly sized heatsink that proved sufficient, but the Gigabyte Aorus has a massive heatpipe and radiator cooler. Inland's TD510 has a tiny and noisy little fan attached to the heatsink. Is it necessary? Not in our testing, though in PCs with less airflow it might help. Corsair's MP700 was supposed to include a fan and heatsink as well, but Corsair axed that, and instead requires that the motherboard have a sufficient cooler.

The good news is that prices on SSDs have plummeted over the past six months. The bad news is that while $280 for a 2TB PCI 5.0 drive might not sound too bad, that's over twice what you'd pay for a Solidigm P44 Pro 2TB, one of the faster Gen4 SSDs. Even if your PC can support a Gen5 drive, you likely won't notice the difference.

But never mind this. The PCI Express 6.0 specification was finalized in January 2022, and PCI-SIG is already working on PCIe 7.0. When will we get 6.0 platforms and drives? Check back in a couple of years.

inland
Gen5 SSD
MP700
Crucial T700
2TB
AORUS
crucial
T700

The shipping M.2 PCIe 5.0 SSDs have two shared traits: the Phison E26 controller and Micron 3D NAND.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

BEST CPUS FOR GAMING

WITH THE RELEASE of the AMD Ryzen 7 7800X3D (see review, page 74), we're now able to see how the current-gen CPU market shakes out for gamers. The good news is that you don't need a huge budget to get a processor that will give you great performance and last for years to come, although as always, you can still up the budget if you want something that does more than just game. Here are our top picks.

AMD
RYZEN
AMD Ryzen 9 7950X

5

AMD RYZEN 9 7950X

Although now slightly superceded by the AMD Ryzen 9 7950X3D (featured in this month's cover build), you are at least able to get a bit of a bargain on AMD's previous top-end CPU. It's still the best all-round AMD processor at present, with a fancy new heatspreader design, and while it certainly gets worryingly warm, it's also blazingly fast. Our Cinebench R23 tests saw this chip tipping the odd core up to a crazy 5.9GHz under load. **$700, www.amd.com**

INTEL® CORE™ i9
i9-13900K
SRL4H
V1341690

4

INTEL CORE i9 13900K

Intel's current top-end consumer chip is a fantastic workhorse that you can confidently throw at any challenge, including high-end gaming. That also applies to multitasking and creative workloads—this thing has 24 cores, and is perfectly suited to lots of demanding stuff happening all at once. We also like that the chip has support for older motherboards and DDR4 RAM, meaning you might not have to spend money upgrading your whole system to join in on the 13th-gen fun. **$589, www.intel.com**

AMD
RYZEN
AMD Ryzen 7 7800X3D

3

AMD RYZEN 7 7800X3D

There is an argument to be made for the AMD Ryzen 7 7800X3D being the best gaming CPU around. It's certainly the best gaming chip that AMD has ever made, but it's also outperforming Intel's top CPU when it comes to gaming frame rates, and doing so for a lot less cash. It's not as good at other workloads, but while it's not a jack of all trades, it certainly is a master of gaming. **$450, www.amd.com**

2

INTEL CORE I5 13400F

For a gaming PC, there's no better-value CPU than a Core i5. The 13400F is only a handful of frames shy of the nearly three times as costly Core i9 13900K in *Total War: Three Kingdoms* and *F1 2021*. There are some anomolies though in a handful of titles like *Far Cry 6* and *Shadow of the Tomb Raider*, which were a lot slower than on Intel's high-end processors. But you can't argue with the value here. **$200, www.intel.com**

1

INTEL CORE i5 13600K

We love Intel's mid-range chip, which will be the right CPU at the right price for the vast majority of PC gamers, as it matched the previous-gen top-end Core i9 12900K in many of our tests. Real-life performance doesn't match up in every regard, but it delivers something similar in gaming for a lot less money. It's also a all-round powerhouse for editing, streaming, and anything else you care to ask of it. **$300, www.intel.com**

INTEL® CORE™ i5
i5-13600K
SRMBD
L234E621

© INTEL

Jeremy Laird

TRADE CHAT

Everybody chill, PC sales are not imploding

PC SALES NOSEDIVED by about 30 percent in the first quarter of this year. But that is no reason to panic—pretty much all digital devices have taken a hit of late. Besides, if you bother to give the numbers more than a cursory glance, you'll see that PC sales are remarkably strong.

To get more specific, two leading research outfits have released numbers for PC sales covering the first quarter of 2023, and it's not pretty. Canalys reckons PC shipments tanked by 32.6 percent compared to the same period in 2022, while IDC puts it at 29 percent. Cue tales of woe across online media and the broader commentariat.

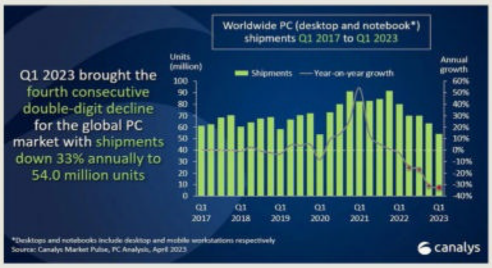
IDC notes that PC sales now are worse than before the pandemic, implying that the fall is more than a mere readjustment following an uptick in sales during that stay-at-home period. But that isn't actually right. Instead, even taking the recent drop into account, PC sales are still up overall.

For several years prior to the pandemic, PC sales ran at about 60 million units in the first quarter of every year, and then roughly 65 to 75 million for each of the remaining three quarters. But during the bizarre pandemic boom, shipments ran at 80 million units plus for seven consecutive quarters, two of which were up around 90 million.

The fact that PC shipments fell back to the mid-to-high 50 million mark in the first quarter of this year, depending on whether you use Canalys or IDC's figures, does not mean PC sales have tanked. On the contrary, overall PC sales are still massively up over the last couple of years.

Canalys suggests that interest rates are to blame for flagging PC shipments, noting that shipment volumes have fallen for four consecutive quarters. But isn't the point that people don't need to repeatedly buy brand new PCs in short order?

> If anything, the real story is how little that demand has dipped



Nice graph, but it's really not that complicated.

© CANALYS

A whole bunch of PCs got bought from late 2020 through early 2022—far more than usual—and those PCs do not already need replacing. Those purchases almost certainly brought forward upgrades that would have happened a little later on. The net result is that demand is now flagging a little.

If anything, the real story is how little that demand has dipped. You might think that if something like an extra 100 million extra PCs were bought during the pandemic then volumes would dip by a similar amount once life went back to normal, but we've actually seen only a small dip. Even more remarkably, analysts are predicting an upturn in shipments in the second half of this year. If that happens, the net impact of the pandemic years will unambiguously be more PC sales.

None of this leaves the analyst industry looking too clever. All you have to do is briefly scan their graphs with the knowledge of that stay-at-home inspired spike in demand to understand what has been going on. To talk about four quarters of declining growth without accounting for that context is to miss the point.

It's a classic case of not being able to see the wood for the trees. That and the temptation for these companies to favor the most superficially technical and jargon-infused narratives, the better to look clever and justify pricey access to the longer versions of their market research.

Observing that everyone went a little crazy buying stuff during the pandemic and that's catching up with the market a little doesn't fill the pages of a premium-access report as effectively as reams of interest rate analysis and millimetric plotting of growth curves, as if profound insights lie therein. We've all got to earn a dollar, I guess.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES…

> M.2 NVMe adapter
> Free surveillance
> Docker install

M.2 adapter for storage

I'm considering building a small-factor NAS-like server based on an ASRock J4125-ITX board in a four-bay tower. I need to keep the PCI-e slot free for a TV tuner card, and want to use all four onboard SATA ports for storage, so I was wondering if I can run the OS from a NVMe drive plugged into the M.2 (Key E) slot?

—Martin Bilton

THE DOCTOR RESPONDS: The short answer is yes. There are numerous adapters that can convert the Key E slot into one for plugging in both SATA and NVMe drives. If all you need is extra storage, search eBay for 'M.2 key A+E male' to add two SATA ports via a $10-15 adapter. The Doc recently fitted one with a JMB58x controller to replace a PCIe SATA adapter, and it works perfectly.

You specifically talk about booting from an NVMe drive, and the Doc can also confirm that this is possible, having seen one working. Despite the fact that the Key E slot runs at PCIe 2.0, meaning you won't get anywhere near NVMe's theoretical top speed of around 3Gbps, you should be able to eke out better performance from it than with a standard SATA SSD drive.

Turn a redundant M2 E-key slot into extra storage ports.

Given that NVMe adapters (see www.ebay.com/itm/393229097064 for one example) cost around the same as the SATA adapter, your only consideration at this point is whether there's enough space in the case to accommodate the NVMe drive itself, which has to be mounted vertically.

If that proves to be a dealbreaker, but you're determined to go with NVMe over SATA, the Doc has an alternative approach. It involves allocating the motherboard's solitary PCIe 2.0 x1 slot to your boot drive and replacing the TV tuner. For under $65, you can purchase both the required PCIe x1 NVMe adapter (around $12-15 online, see www.amazon.com/dp/B082D6RF6S/) and the low-powered 1TB Patriot P300 M.2 ($49.99, www.amazon.com/dp/B082BJ4679/).

That leaves you with the task of sourcing a replacement TV tuner—a USB tuner costs as little as $30. If you're feeling flush, why not investigate a network-based option like HD Homerun's Flex (local TV) or Prime (cable TV) tuners? See https://www.silicondust.com/hdhomerun/ for details, and remember to make sure the tuner is compatible with your operating system (in the case of the HD Homerun boxes, you'll need to source a media server like Jellyfin or Plex that supports them).

Subscription-free surveillance

I'm looking for a home surveillance system that is 'self-contained'. I could be wrong or overlooking something, but every home surveillance product that I see requires an internet connection and a fee for recording and holding the video off-site for a specified time. Is there a way to set up a home surveillance system that is self-contained within a person's home? If so, maybe an article can be written to address all the hardware and software required to make it work. How to set it up and integrate with the desktop computer and possibly a mobile device would be of interest too.

There may be many others like me, who refuse to pay a monthly fee for any computer service except for my internet carrier. Whatever it is, I want to purchase it, maintain it, and keep it to myself. I do not want to rent it, lease it, or have a third party involved. Perhaps it's paranoia or preference for independence, but I strive to have full control over my personal space.

—Mike Burkhead

THE DOCTOR RESPONDS: The good news is that yes, you can keep your recordings to yourself. Some cheap eBay webcams, based on the V380 Pro app, come with SD card slots to let you keep recordings without a subscription, but you still need to register the webcam with the app to access recordings and monitor your camera remotely, and it aggressively promotes its cloud-based subscription whenever it can.

↘ submit your questions to: doctor@maximumpc.com

An option for those with a Synology and QNAP NAS is their built-in surveillance software—Surveillance Station (www.synology.com/en-us/surveillance/overview) and QVR (www.qnap.com/en-us/utilities/surveillance) respectively—that work with a range of local and network (IP) cameras and let you store your recordings on your NAS rather than the cloud. They're free for use with up to two cameras, and video feeds are AES-256 encrypted when streamed, but you'll have to pay if your setup requires more cameras.

One open-source option does exist, and that's based around the Motion and MotionPlus (https://motion-project.github.io/) protocols. It is a little fiddly to set up, but you won't have to pay for streaming or recording from your surveillance cameras.

The most promising is MotionEye (https://github.com/motioneye-project/motioneye), which can be installed through Docker or Linux. The Doc has tested the former with a USB webcam attached to his Ubuntu-powered server, as well as an old Android phone over Wi-Fi, and it should work with other network/IP cameras, the Raspberry Pi camera, and selected composite video cards.

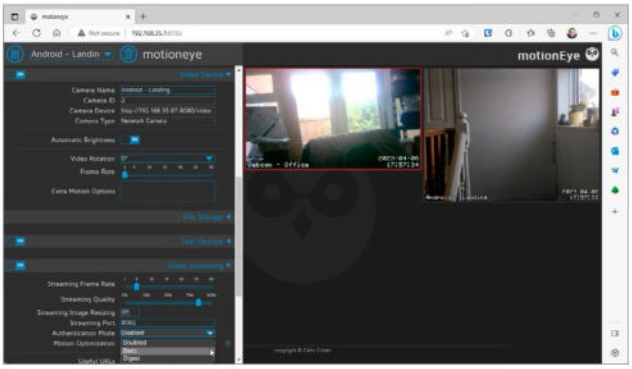
Color display question

If the three primary colors are red, blue, and yellow (with yellow and blue making green), then why do displays use red, blue, and green to get their colors?

—Chris Williams

THE DOCTOR RESPONDS: The notion of red, yellow, and blue (RYB) as the primary colors goes back to the 17th century, based on artists' experience mixing pigments together. On the other hand, the science of light posits that red, green, and blue (RGB) are the actual primary colors, with yellow a mixture of red and green light. The popularity of the RYB model sees many digital artists continue to use a RYB wheel. It also explains the use of CMY (cyan, magenta, and yellow) and CMYK (the 'k' being an additional black ink) cartridges in printers, which follow the RYB model, and are used in magazine printing due to their more accurate color reproduction.

Digital displays use RGB because they can reproduce a wide range of colors from mixing the three together, meaning LCD pixels can be made up of three subpixel elements, one for each color.



motionEye is an open-source solution for home surveillance.

© MOTIONEYE

Cockpit not Docker-friendly

I am having an issue with Docker containers not working in the Cockpit Dashboard on my Ubuntu Server NAS. When I select 'Docker containers' from the left-hand menu, it displays 'Oooops' in red. Then it reports that 'Cockpit had an unexpected internal error'. Have you seen this issue when trying to use Cockpit with Docker containers? I would appreciate any suggestions, as I have been unable to find a resolution.

—Frank Gunseor

THE DOCTOR RESPONDS: It sounds like you may have built your Ubuntu Server NAS following our older guide back in 2021, Frank. We'd installed an outdated version of cockpit using Ubuntu 20.04's default repo that—at time of writing—supported cockpit's Docker module. The module had been retired, as cockpit's developers chose to support Red Hat's Docker alternative, Podman (https://podman.io/).

When cockpit switched support, Podman was in the early stages of development, and not ready for primetime. Its Docker module worked, but as time went on, it became less reliable. By the time we wrote last year's Ubuntu Server NAS feature, we'd updated Ubuntu to 22.04 LTS and installed cockpit through the Jammy Jellyfish 'backports' repository, which enables cockpit to stay up to date instead of being 'stuck' at the version installed when Ubuntu 22.04 LTS came out.

This means that Docker containers can no longer accessed through cockpit—you can switch to Podman if you like, which is compatible with regular Docker containers, or try a different web-based UI. We recommend Portainer (www.portainer.io), which offers a more powerful frontend than cockpit's original Docker module, and requires access through a separate tab. For a guide to setting up Portainer, check out our Docker tutorial in the October 2022 issue.

Use Docker in Windows

I'm intrigued by your many tutorials that use Docker-based containers to run services on your computer. I need to run WSL 2 to access Docker on my Windows PC, but am having trouble getting it running. Can you help me please? **—Jeffrey Ryder**

THE DOCTOR RESPONDS: WSL 2 is basically the Windows Subsystem for Linux, which allows you to run a wide variety of Linux distributions in Windows. However, it requires hardware virtualization. To check this is enabled, right-click the taskbar, choose Task Manager, then Performance, and check the Virtualization status under CPU.

If it's set to Disabled, reboot into your UEFI/BIOS and look for the settings you need under CPU. These can be tricky to find, as they can be called a number of things: VT-x, AMD-V, SVM, or Vanderpool are options. In addition, enable an Intel VT-d or AMD IOMMU option if it's present. Check your motherboard manual or ask on your motherboard support forum to find the required setting.

Once virtualization is enabled, the quickest way to install WSL 2 (based on Ubuntu 22.04 LTS) is to right-click the Start button and choose Terminal (Admin), then type the following command and hit Enter:

```
wsl --install
```

Once installed, reboot your PC and a Terminal window will open asking you to set up your Linux username and password. Once done, WSL 2 will be in place. You can install Docker Desktop for Windows (see https://docs.Docker.com/desktop/install/windows-install/) if you wish, or install Docker into Linux from the Terminal by following the instructions at https://docs.Docker.com/engine/install/ubuntu. Before starting the Docker service, enter the following command:

```
sudo update-alternatives
--config iptables
```

Select option 1 (iptables-legacy), hit Enter, then start the Docker service. You should now be able to run Docker containers from the Terminal in Windows. ⏻

BUILD A GAMING POWERHOUSE

Introducing AMD's latest and greatest chip, the Ryzen 9 7950X3D. The gaming CPU to beat?

WITH INTEL'S POWERHOUSE Core i9-13900K taking the limelight in some of our most recent stand-out builds, it was inevitable that we'd follow up with AMD's top challenger. After getting our hands on the Ryzen 9 7950X3D, we simply had to pair this with the most powerful GPU on the block, Nvidia's RTX 4090. These two components alone should ensure our machine is packed to the brim with power, so you know we had to face it against our 8K gaming monster machine Guy built in our Holiday 2022 issue. Will AMD's CPU take the throne, or sit in second place? With tricks up its sleeve like 3D V-Cache, 16 cores, 32 threads, and up to 5.7GHz max boost frequency, it will surely put up a good fight.

Processors aside, the rest of the internals had to match in terms of quality, so we made sure of that. Super-speedy RAM, loads of lightning fast storage, and enough fans to turn this build into a hovercraft? Check. We also chose a sleek chassis to house all of these impressive components: the Phanteks NV7 full tower case. Hiding these parts away would be a sin, so by having a case with two large glass panels, everything is on display. Choosing an all-white color scheme should make the RGB lighting pop too, so we can make it match any theme. It also should give us plenty of space to build in, making the whole process smoother. Win-win, right? Let's move things along and see what this system adds up to.

INGREDIENTS

PART		PRICE
Case	Phanteks NV7 Full-tower ATX	$219.99
Mobo	NZXT N7 B650E	$319.99
CPU	AMD Ryzen 9 7950X3D	$699.99
CPU Cooler	NZXT Kraken X73 RGB 360mm	$224.99
GPU	NVIDIA Geforce RTX 4090 Founders Edition 24GB	$1,599.00
Memory	32GB (2x 16GB) ADATA XPG Lancer RGB DDR5-7200MHz	$229.99
SSD	2x 1TB ADATA Legend 960 PCIe 4.0 NVMe SSD	$169.98
Intake case fans	3x Corsair LL120 RGB 120mm Dual Light Loop White RGB LED PWM Fan	$89.99
Exhaust case fans	3x Corsair iCUE SP120 RGB ELITE Performance 120mm White PWM Fan	$79.99
Fan controller	Corsair iCUE Commander Core XT	$229.00
PSU	NZXT C1000 1000W 80+Gold	$179.99
OS	Windows 11 Home 64-bit OEM	$32.00
TOTAL		**$4,144.90**

PRICES CORRECT AT THE TIME OF PRINTING

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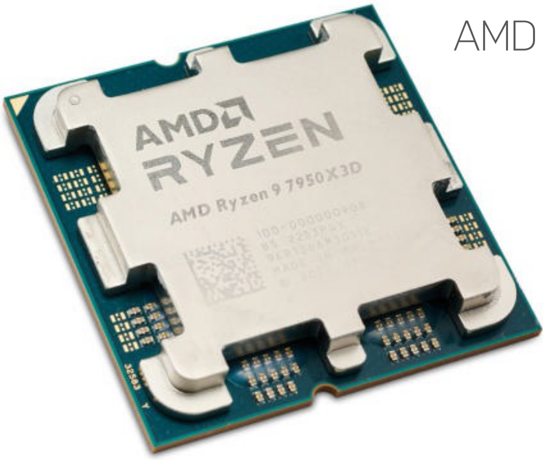
Please type this URL into your browser if link is broken

NZXT
XPG
XPG
NZXT
GEFORCE RTX
PHANTEKS

BUILT AND TESTED STEP-BY -STEP GUIDE **PG.23**



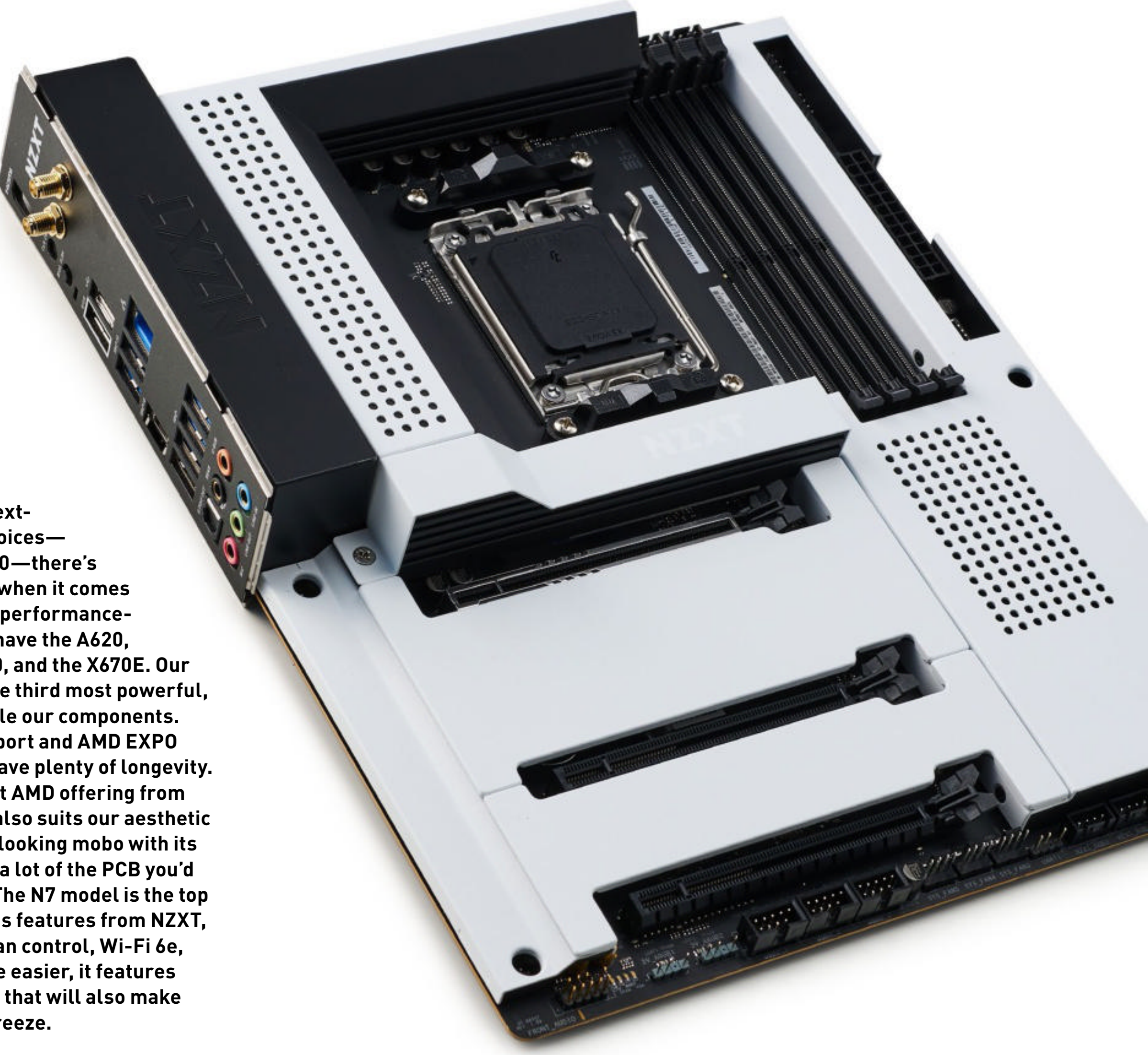
CPU

AMD RYZEN 9 7950X3D

WWW.AMD.COM

Here it is—the star of the show. Can this AM5 powerhouse take on the likes of the 13900K or 13900KS as the best gaming CPU available? Its stats would certainly imply that it has a very good chance. As we mentioned earlier, there are 16 Zen 4 cores, 32 threads, and a max turbo frequency of 5.60GHz lurking under its shiny exterior. It's no slouch by any means. What sets it apart is the 3D V-Cache, which unlocks 128MB of L3 cache to play with. This is the second iteration of 3D V-Cache from AMD, with the first leapfrogging over Intel's top chips at the time. Will history repeat itself, and will AMD take the crown once again?

• ***Price $699.99***



MOTHERBOARD

NZXT N7 B650E ATX

WWW.NZXT.COM

Compared to Intel's next-generation chipset choices—either the Z690 or Z790—there's far more to pick from when it comes to AMD's offerings. In performance-ascending order, you have the A620, B650, the B650E, X670, and the X670E. Our chipset, technically the third most powerful, is still enough to handle our components. It boasts PCIe 5.0 support and AMD EXPO technology, and will have plenty of longevity.

This B650E is the best AMD offering from NZXT, and this board also suits our aesthetic perfectly. It's a great-looking mobo with its white paneling hiding a lot of the PCB you'd see on other boards. The N7 model is the top of the line with regards features from NZXT, with digital RGB and fan control, Wi-Fi 6e, and more. To make life easier, it features a built-in FLBK button that will also make updating the BIOS a breeze.

• ***Price: $319.99***

XPG
XPG
DDR5

RAM

ADATA XPG LANCER RGB 32GB (2X 16GB) DDR5-7200MHZ

WWW.ADATA.COM

DDR5 has plummeted in price since its release, but what hasn't plummeted is the speed. A kit this speedy would have cost you an arm and a leg back when DDR5 first made its appearance. Sure, it's not cheap, but we are moving in the right direction. Anyway, yes your eyes don't deceive you; this RAM kit boasts speeds of up to 7,200MHz. That's some mighty fast performance, and if you're not a fan of closing down your tabs then hey presto, this will be your new best friend. In all seriousness though, 32 GB is more than enough when it comes to capacity, and running at this pace, it will certainly work hand-in-hand with our Ryzen 9 7950X3D for ultra-fast processing speeds.

• Price: $229.99

GPU

NVIDIA GEFORCE RTX 4090 FOUNDERS EDITION 24GB

WWW.NVIDIA.COM

To match the overkill power from our CPU, we had to bring in the best GPU on the market right now. Well, not technically the faster variant of this card; the founder's edition is where it all begins and showcases the new Ada Lovelace architecture. With 24GB of GGDR6 memory and DLSS 3 support, it's a large step in both performance and efficiency over the previous top card from Nvidia, the 3090Ti. As we will be comparing this against Guy's Holiday 2022 build, it's important to note that the MSI Gaming X TRIO 4090 GPU used there has a slightly larger boost clock score with an increase of 75MHz, though that's not to say that this Founders Edition is lacking in the speed department.

• Price: $1,599.99

BUILT AND TESTED
STEP-BY-STEP GUIDE
PG.23

ADATA
LEGEND 960

PERIPHERAL
DO NOT USE

PRIMARY STORAGE

2X 1TB ADATA LEGEND 960 PCIE 4.0 NVME SSD

WWW.ADATA.COM

In this build, we knew we needed loads of storage so we could fill the system with triple-A games, even for older titles we've already sunk countless hours into, just to crank the sliders all the way to the max. We could have gone down the mechanical HDD route, but we wanted some speedy drives to reduce loading and transfer times. Meet our main drive—or shall we say, drives. Due to a short stock issue and two individual 1TB ADATA Legend 960s being cheaper than one 2TB model, we ended up with two 1TB drives. For under $100 each, you get great value for money. Read speeds of up to 7,400 MB/s and write speeds of up to 6,800 MB/s make this a cracking primary drive.

• Price: $169.98

CPU COOLER

NZXT KRAKEN X73 RGB 360MM

WWW.NZXT.COM

Our main source of cooling for the AMD Ryzen 9 7950X3D is a slick-looking solution, the NZXT Kraken X73 RGB. It contains three NZXT Aer RGB 2 120mm fans and a 360mm radiator to ensure our CPU keeps cool. Despite not being the range-topping Kraken Z73 model with an LCD display, this has an infinity display, which offers fewer features, but saves us $80. Within the NZXT CAM software, you have very fine controls over the RGB lighting, even the colors within the infinity display. We opted for the white variant to match the rest of our system, too.

• Price: $224.99

NZXT
ERBOARD 20+4
CPU & PCI-E
SATA
CPU & PCI-E
ODULAR CABLES FROM OTHER POWER SUPPLIES
NZXT C1000

POWER SUPPLY

NZXT C1000 1000W 80+GOLD

WWW.NZXT.COM

GPU aside, this system is going to draw a lot of power, so you know we needed to get a very dependable PSU to handle it. We've used the C1000 from NZXT before, because as an 80+ Gold power supply, it delivers dependably and efficiently. Being fully modular, it also helps with cable management, as we can pick out and use only the cables we need, with no excess making a mess inside of our NV7 chassis.

For an RTX 4090 GPU, an 850W PSU is recommended, so we are being on the safe side here with 1000W. We'd rather have excess power than be cutting it fine. This should also allow for a small amount of overclocking down the line, if we wish.

- *Price: $179.99*

BUILT AND TESTED
STEP-BY-STEP GUIDE
PG.23

CASE

PHANTEKS NV7 FULL-TOWER ATX

WWW.PHANTEKS.COM

Phanteks seems to nail both function and aesthetics—a tradition which continues on this NV7. It's a large case, being a full-tower form factor, and it certainly isn't lightweight, coming in at 37.25 lbs, but once you've built this, you won't be needing to move it around much.

Weight and size aside, this case looks awesome. Its glass corner design allows us to see our internals and the RGB lights that illuminate the space.

It features various cooling placement options, enough cable management routes to last a lifetime, and a vertical mount for your PSU above the motherboard. The NV7 is minimal, practical, functional, and packed with features, which should make a great match for our powerful components.

- ***Price: $219.99***

INTAKE FANS

(3X) CORSAIR LL120 RGB 120MM DUAL LIGHT LOOP WHITE RGB LED PWM

WWW.CORSAIR.COM

There are an infinite amount of cooling configurations, especially within our Phanteks case. We've chosen two types of fans: 3x airflow and 3x static. Of course, we also have the 3x exhaust NZXT fans bringing cool air over the AIO radiator. That aside, we've gone with the LL120 static pressure fans from Corsair to bring cool air from the bottom and across the motherboard. There's a mesh cover at the bottom to help with dust, so we needed a stronger pressure fan to pull the cold air into the chassis. *• Price: $89.99*

FAN CONTROLLER

CORSAIR ICUE COMMANDER CORE XT

WWW.CORSAIR.COM

To keep our fans in check, we need to introduce a fan controller. To eliminate compatibility issues, we went with Corsair's iCUE Commander Core XT. It has space for up to six fans, which is conveniently what we have: six headers for the fans and six for the RGB cables. Having this controller allows us to use more fans than the motherboard has available headers, and frees up space around the front to keep cable management in check. We could then include more fans at the back (crazy, but it's possible). *• Price: $59.99*

RGB HUB
6
5
4
3
2
1
ID
TEMP 1
TEMP 2
RGB
FANS
6
5
4
3
2
1

EXHAUST FANS

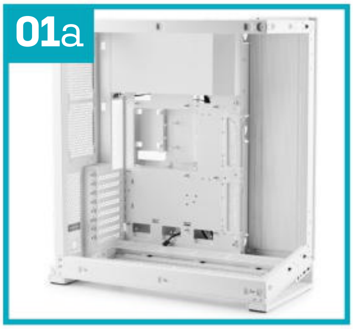
(3X) CORSAIR ICUE SP120 RGB ELITE PERFORMANCE 120MM WHITE PWMI

WWW.CORSAIR.COM

For our exhaust system, we've chosen airflow fans. These push a tighter, more concentrated spread of air than static pressure fans, which should expel a stronger flow out the back. Again, we've gone with Corsair, specifically the iCUE SP120 RGB ELITE performance fans. Compared to our LL120 static pressure fans, these have smaller blades, but wider gaps between them to create a tighter flow. Also important was keeping to the minimal white aesthetic of the build—can't you tell already? *• Price: $79.99*

© CORSAIR

KING OF THE RING IS THIS REALLY THE FASTEST GAMING PC?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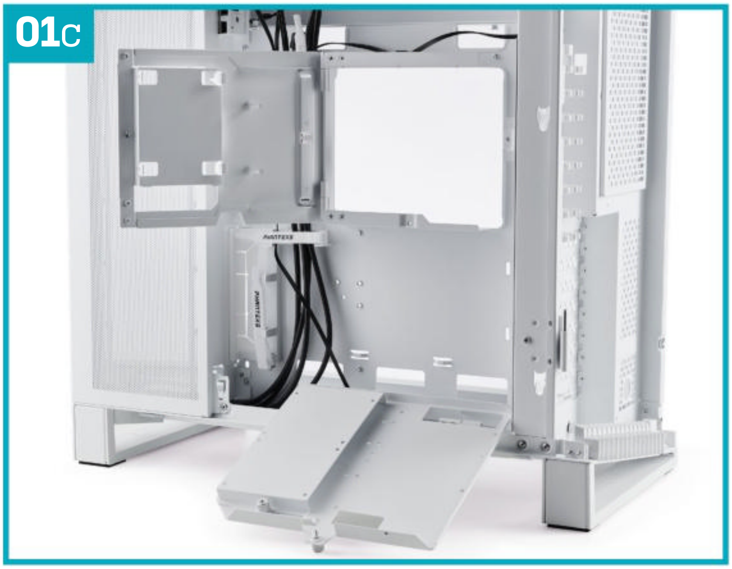
02a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LENGTH OF TIME: **2-3 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

01 *A* **Less is more**

Just like clockwork, we start our build off by taking our case apart. Seems counterproductive, right? Well, what this does is help us figure out what we're working with and give us as much room as possible inside the case for later on. Trust us, when it comes down to cable management, you'll be thanking yourself for doing this step at the start of every build. This NV7 from Phatneks has a lot, and we mean *a lot* of removable parts and panels. To get going, open up the door at the back of the case—this is on a hinge, and there is a gap at the bottom to open it. Then, we can remove this entirely by lifting it up. With this gone, it reveals the thumb screws that keep both the front glass panel and back metal panel on. Loosen these, and the panels will simply slide off. The smaller glass panel can now also be removed by sliding it forward. The last thing to do here is get rid of (put safely aside) the top panel by, you guessed it, sliding it off.

01 *B*

Internally, there is a top RGB bar and a cover that sits around the motherboard. Before we get to installing that, we can remove these. The RGB cover slides right and pops out. There's a small screw towards the bottom of the motherboard cover, and that then releases it, allowing it to be lifted out.

01 *C*

Around the back, there are doors that we can open by loosening the screws that are attached. This will give us more room to keep our cable management neat and tidy later on, and provide us with a flat surface to install our Corsair iCUE Commander Core XT.

02 *A* **Working top to bottom**

Unlike usual, we're now going to install our PSU. Due to the different positioning of the PSU in this case, we wanted to get this out of the way first. Instead of sitting flat at the bottom, it sits vertically towards the top, with the fan facing outwards. Installation isn't any harder; it just requires four case screws to tighten it to the chassis.

02 *B*

At this stage, we also thought it would be a good idea to install the PSU cables straight to the PSU first. With a lot of extra cables from the fans and AIO inevitably infiltrating the back of the case later on, we decided to run these along the back first, as they'll only be more frustrating to install towards the end.

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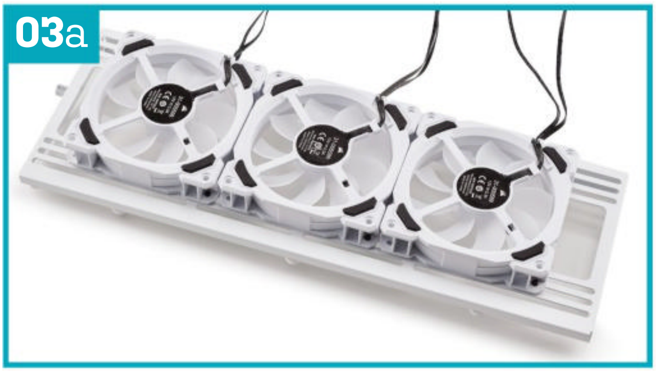

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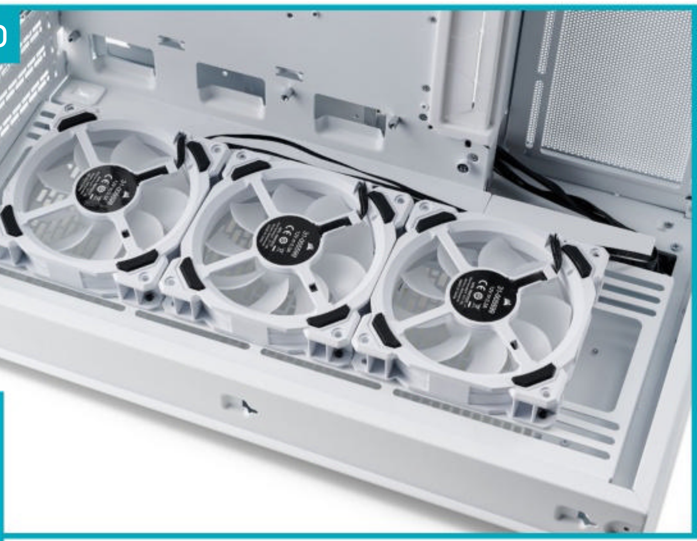

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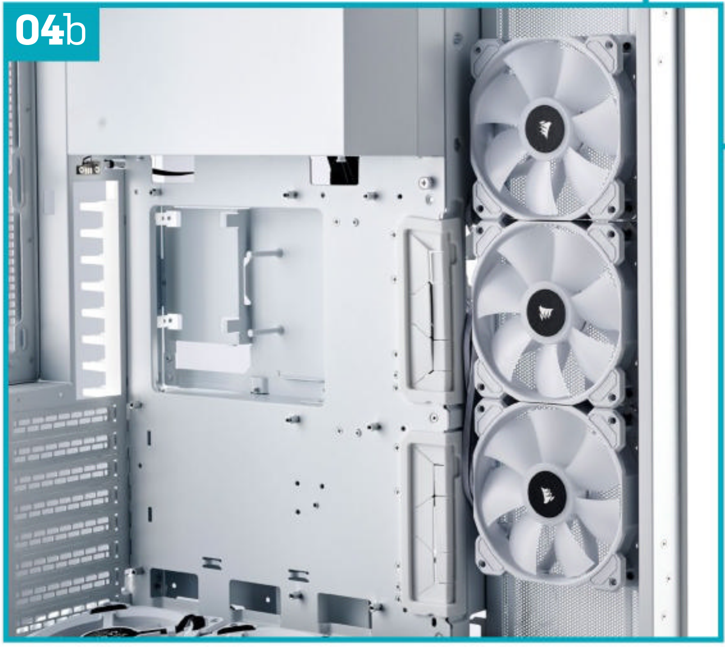

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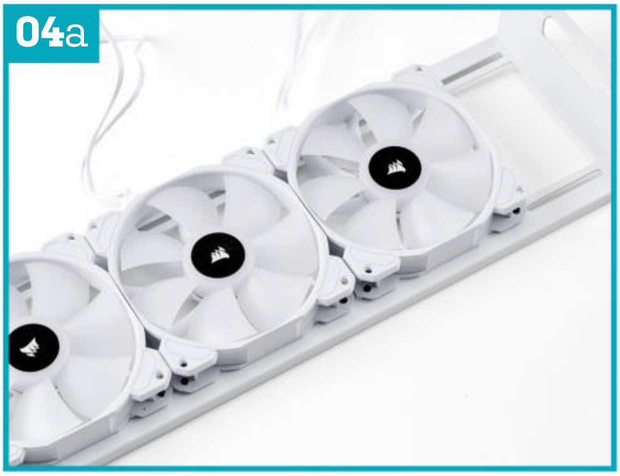


03 A Intake fans

When we said that this Phanteks NV7 case has a lot of panels, we weren't lying. To help with fan installation, there is a bottom rack that can be removed, too. Screws seated in rubber grommets around the back, underneath, and to the left of the rack keep this in place. Undo these, make sure not to lose the rubber grommets, and you can slide this out. With this removed, we can install the fans. Always make sure you remember which way the rack came out so that when you install the fans onto it, they are in the correct position.

In our case, we wanted the fans facing outward, as the faces suck—that's the phrase you need to remember. This meant we were pulling air from the bottom upwards into the case, so place the fans face-down on the rack, starting with one right in the center so you can keep them equally spaced from the edges. Once in place, use case screws to tighten each corner. Make sure they are all the same orientation so the cables run out the back, making it easier to manage.

03 B To finish this step, install the rack back into the case by doing all the steps to remove it, just in reverse. Not too bad, hey? The rubber grommets can be frustrating to get back into place, as I can personally attest, but be patient.

04 A Exhaust fans

Similar to the intake fans, the exhaust fans sit on a removable rack to make life even easier. With a screw on the top and bottom holding this rack in place, simply loosen it to lift it out. As these fans will be expelling the air, the faces need to face inwards so they suck the air outwards. In this configuration, we'll get to see the RGB goodness in all of its glory. Make sure all of the cables are facing to the left so they can be pulled straight towards the back panel of the case out of the way to make the front neater.

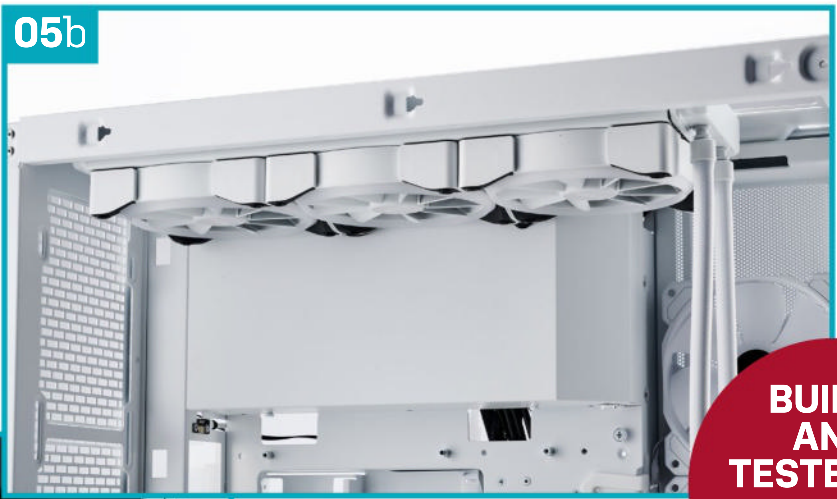
04 B To secure the fans onto the rack, use the same type of case screw that you used for the intake fans. This is often the largest screw that will come with the case. Always double-check that everything is in the right orientation before tightening it back into position.

05 A Fans galore

Just when you thought we were cool enough, we bring you some more fans. Okay, bad pun, but we couldn't resist. Moving swiftly on, now that all of our case fans are installed, it's time to start with our CPU cooling. That means getting the AIO assembled. We need to connect the fans directly to the radiator first before screwing them to the bottom of the top rack. To secure them together, use the long screws and washers provided with the Kraken X73 kit, and put these through the fan first to secure them onto the rad. We also need to connect all of these fans with the fan-

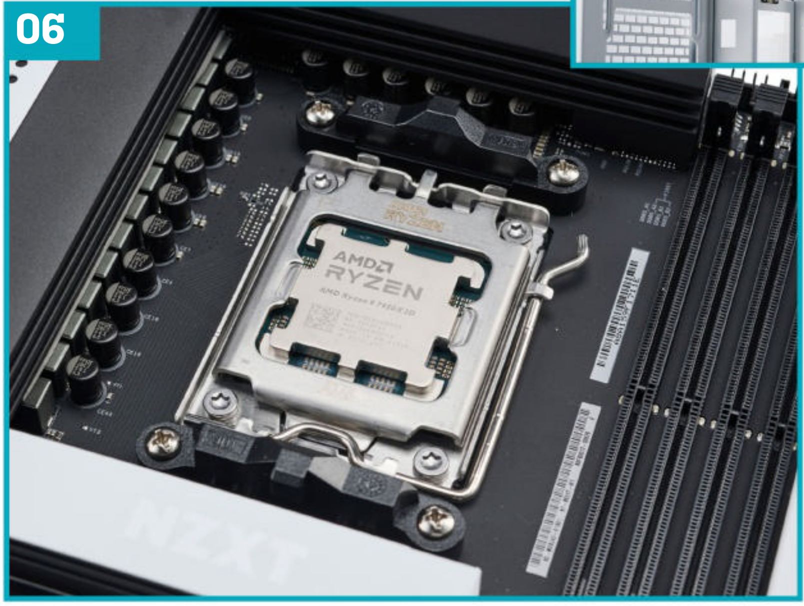
05a

05b



BUILT AND TESTED
STEP-BY-STEP GUIDE

06



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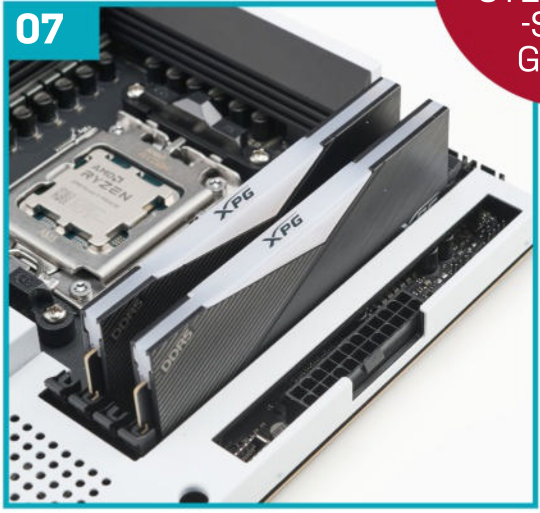


to-fan RGB cables provided at this stage. Then the individual fan cables can be connected to the provided fan splitter which we will connect later on. Finally (cable-wise), we have to connect the 500mm fan connection cable to the first fan on the radiator. This will connect up to another cable on the pump header later. Right, we are all cabled out for now!

05B As we want the airflow to be pulled up over our motherboard where most of the heat will be, we want to continue the same flow of air that we have created from our bottom intake fans, so we need to face these NZXT fans downwards with the radiator sitting on the other side of the rack. This is always quite a fiddly process, but take your time and make sure you get the positioning correct the first time. Once you're happy and with the cables facing towards the back, we can lift this and screw it onto the case. You only need small case screws to do this—these will tighten onto the back of the radiator. Work diagonally to create even tension, and rest the case on its back to make life easier.

06 Fans aside

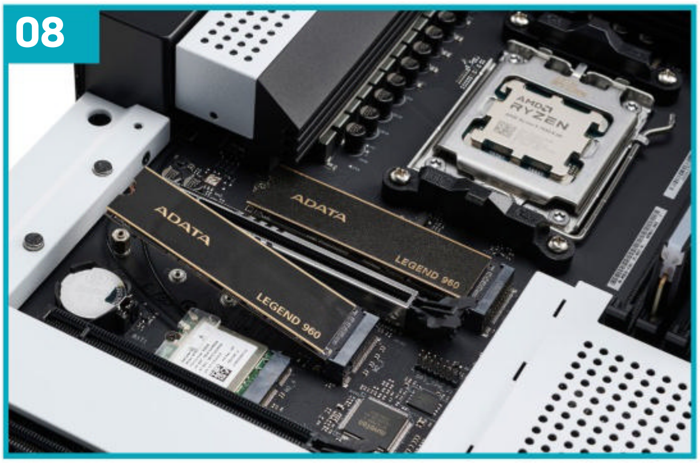
Now our CPU cooler has been installed in the case, we need to prepare the actual CPU—otherwise it's near enough useless. So for now, we'll be putting the case aside and bringing the motherboard into the frame. To open the CPU bracket, raise up the retention bar to the right-hand side of it by unhooking it. This will pop open the cover and reveal the socket. On every motherboard, there will be a triangle right near the socket—align this with the triangle found on your CPU to ensure it's in the correct position. When handling the chip, always hold it gently from the sides. To avoid damage, don't touch the bottom of the processor or the socket directly. After the chip is aligned correctly, rest it down into the socket and then bring the retention bar back into its original position. This will lock it firmly in place. If it's the first time using a new motherboard, there will be a black cover that will automatically pop off after doing this—don't worry, you've not broken anything (hopefully)!

07 Speedy memory

After installing the CPU, we move ever so slightly to the right-hand side to install our RAM. As we only have two sticks, we need to check the motherboard's manual to figure out the order of installation. Of course, if you have four sticks you install them all, but with two, or even one, there are primary slots to use first. For us, these are slots two and four, from left to right. Thankfully, that's the most difficult part of this installation.

Open the clips above and below the 2nd and 4th DIMM slots to make them accessible, then align the notch in the slot with the notch on the sticks so they are the right way round. After this, press them down into position, and you'll hear a click letting you know they're secured.

08



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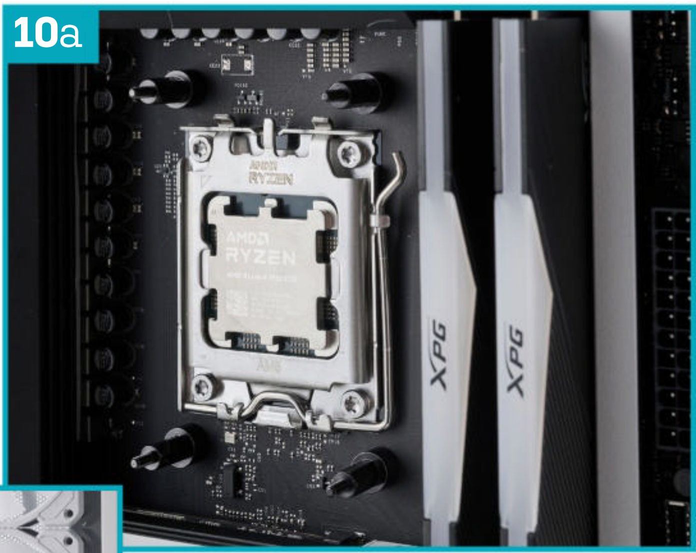

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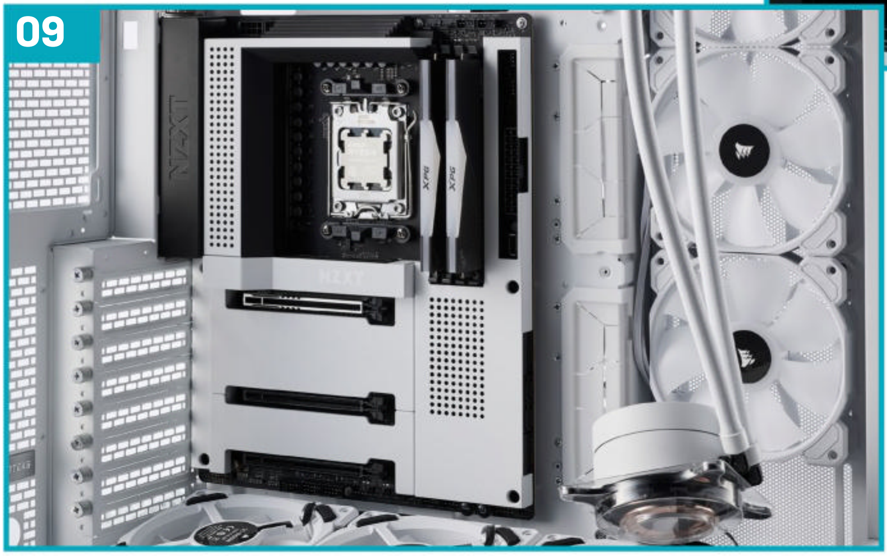

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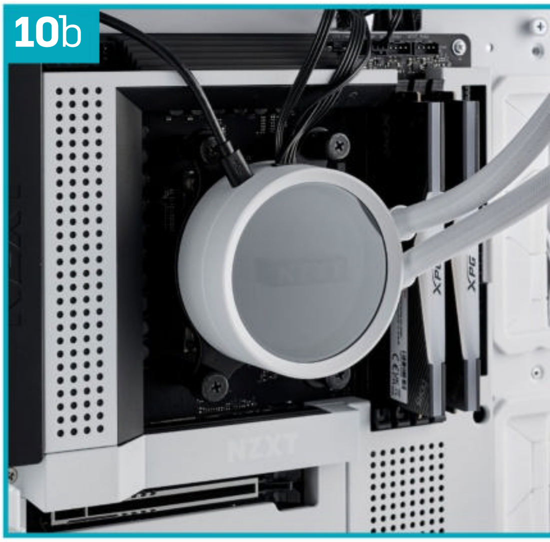


08

Double storage

Below the CPU is where we find the M.2 slots for our SSDs. As we have two of the same model, the order doesn't matter, but typically you'll put your primary drive in the uppermost slot. This has a magnetic heatsink cover, which is also held down by one small screw to the left. Remove this and lift off to reveal the slot. From here, we can lift off the second SSD magnetic heatsink cover that sits underneath.

As you can see from the bottom drive, these install at a 30-degree angle into the port first. Then, using the M.2 screws provided with the motherboard, you can tighten these down flat and reinstall the cover shrouds over the top. Having these heatsink covers helps the build look clean, but more importantly keeps the SSDs running at a lower temperature.

09

Mobo install

As we've now installed nearly all of our motherboard components, we need to install the motherboard into the case, but not before giving yourselves a pat on the back first. This NZXT N7 B650E matches perfectly with the rest of the case, and by having so much room to work with, installing this was a breeze. First, make sure that you line up the I/O shield on the motherboard with the I/O gap in the back of the case. Once that's in place, the rest of the board will fall into place. It may need a small wiggle to make sure the screw holes all align, though. Then, we can start using the case screws to secure this down, tightening diagonally to create an even pressure across the motherboard.

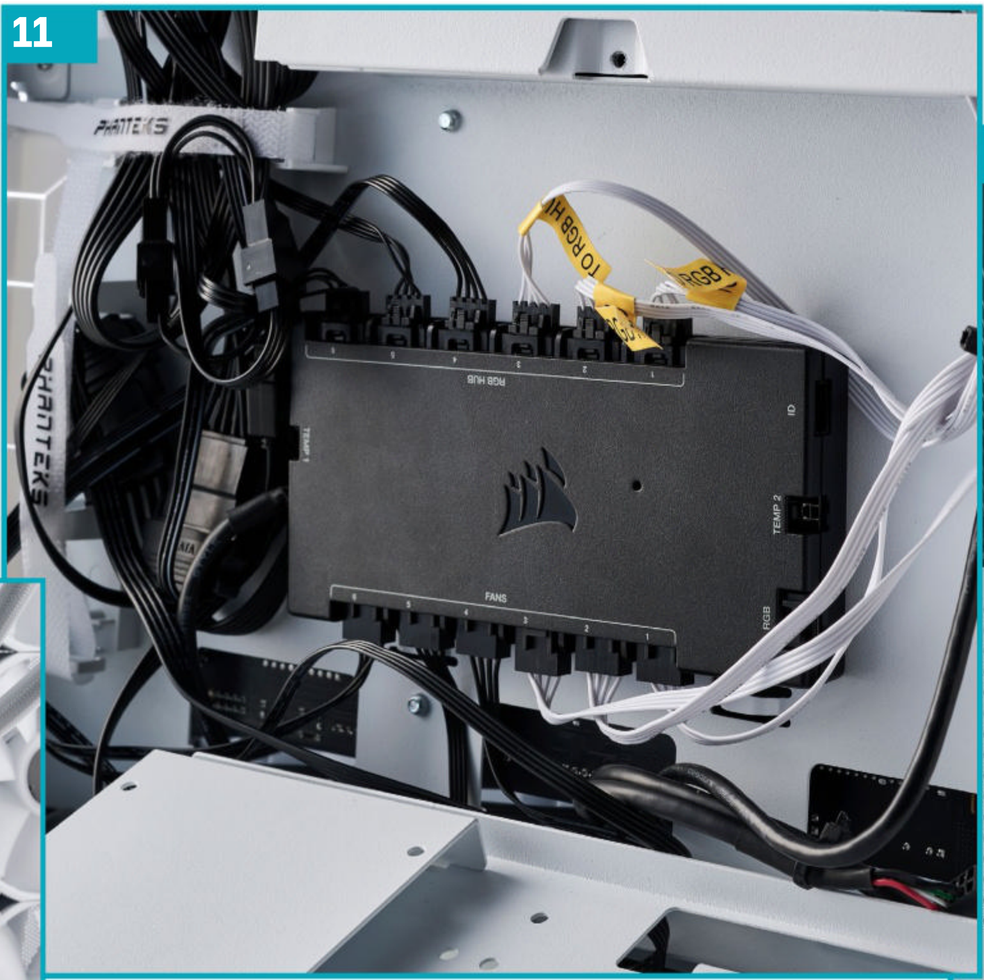
10 A

The brain of the CPU pump

The final part of our cooling system is to now attach the pump header to our CPU, seeing as the motherboard is now in place. Before we get rushing ahead of ourselves with thermal paste though, we need to install the stand-offs onto the board so we can then attach the pump. This requires us to remove the default AM4/5 stock cooler bracket that comes pre-installed on the board. With two screws on either side of each bracket, this is easily removable. In the NZXT Kraken X73 kit, you need to use the AM4 labeled standoffs. These are fully compatible with AM5 chips, like the one we're using in our build. Our motherboard also already has a backplate pre-installed, so all you need to do is screw these standoffs onto the board.

10 B

With that all in place, we can take the pre-installed Intel bracket off the pump and attach the AM4/AM5 bracket. This requires a half turn to secure it in place. At this point, you need to figure out which side you want the hoses to come out of the pump. For us, and for the majority



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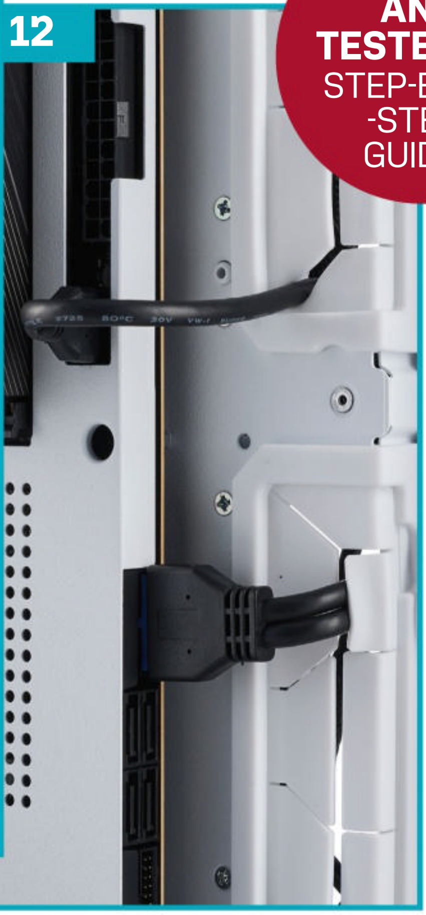


12

of occassions, this is on the right side of the pump. You don't have to worry about the orientation of the NZXT logo, as this is adjustable after installation—turn it until it's level. In the kit, there are four large thumb screws, so once you rest the pump down on the CPU and align the screw holes on the bracket with the standoffs, you can add and tighten these thumbscrews. Please note that this cooler also comes with pre-installed thermal paste on the header—if yours doesn't then add a pea-sized shape of thermal paste onto the center of your CPU before installing the header.

It's also time to connect the cables. We start with the ones that go into the header directly, one of which is a Micro-USB that connects to the pump header, and the other end goes into a USB header at the bottom of the motherboard. We looped this up and around the back of the mobo to keep it clean—the other cable is labeled as the breakout cable set. On this, one end goes straight onto the CPU pump header on the motherboard, another is a SATA connection that connects to a SATA cable from the power supply, and the last one connects to the cable that went into the first fan on the radiator. This took us a minute to wrap our heads around, so don't worry—always refer to your manuals, there's no shame in it.

11 The brain of the fans

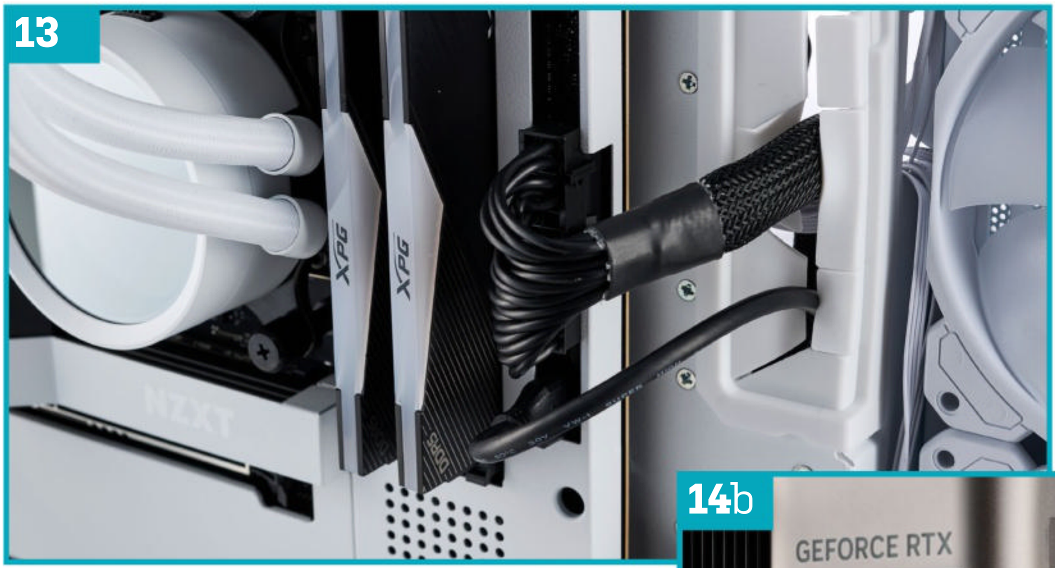
Now that we've started with all of the cabling on the cooling system, we may as well connect up all of our case fan cables to our Corsair iCUE Commander Core XT. If you can remember all the way back at step 1, we opened some door panels to reveal space at the back of our machine. This is where we will install our Commander Core XT. Before we peel off the sticky back adhesive and press it against a clean and open space on the back of your system, just make sure all of your cables can reach it comfortably. After installation, we need to make sure that the order of the cables correlates. What we mean is that both the power cable and RGB lighting cable from one fan have to go into the same numbers on the Commander Core. After installing all 12 cables and making sure they're in order, we can connect the SATA power cable to the SATA PSU cable.

12 Case cables

Can we just be done with cables yet? When will the first fully wireless PC be built with absolutely no complications and steep price tags attached? Okay, we are being a bit dramatic—we're nearly there on the build! At this point, we need to connect our front panel case cables to the case. These include the power switch, USB 2.0 and 3.0, and HD audio lead. It also included two SATA cables for the RGB in the case, connected to our single SATA PSU cable, which had four connectors on it.

If you take a look at a diagram of your motherboard, it will make this stage 1,000 times faster than trying to second guess. We were just grateful that the power switch cables were combined, and not individual pin connectors as they can often be—it certainly saved us some time!

13



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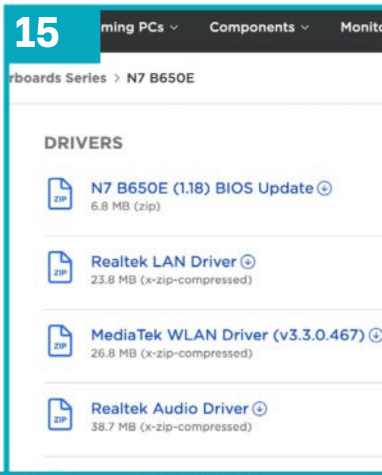


DRIVERS

N7 B650E (1.18) BIOS Update
6.8 MB (zip)

Realtek LAN Driver
23.8 MB (x-zip-compressed)

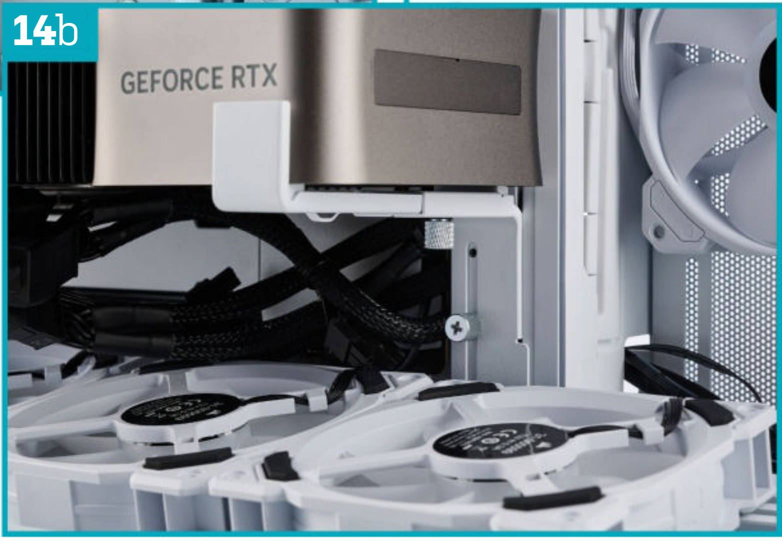
MediaTek WLAN Driver (v3.3.0.467)
26.8 MB (x-zip-compressed)

Realtek Audio Driver
38.7 MB (x-zip-compressed)

14a

AMD RYZEN
XPG
XPG

14b



13 PSU cables

For our system, we needed two CPU PSU cables, four PCIe cables (our only real mishap in this system), a SATA cable, and the 24-pin motherboard cable. As we had already installed these at the beginning, it was a question of just plugging them into the motherboard. Always use the cables provided with the power supply.

Anyway, the two most awkward ones are always the CPU cables, but thankfully with this motherboard and case combo, space wasn't a big issue. It was the PCIe cables that caused us issues—our PSU only had three available PCIe ports, so we had to run our GPU with one less cable. This slightly limits the power of the graphics card, but it's nothing to worry about. Moving forward, we would use a PSU with more available PCIe ports.

14A The feared 4090 and GPU snake

Finally, we can add in the last component of the build, the mighty Nvidia RTX 4090 Founders Edition. For the uninitiated, this is a large card which takes up the space of three PCIe shrouds at the back of the case. These are all removable with a Philips screwdriver. Just like the RAM, the GPU clips into a slot, specifically the uppermost PCIe slot. Open the clip first and then line up the connector with the port and push in until it clicks. Then, remove from the shrouds from the back of the case, and tighten the GPU directly into the case.

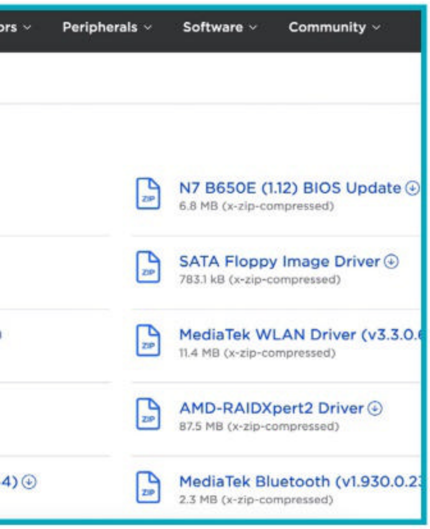
Now, let's focus on the cables for one final time. Lacking in one head, this three-headed GPU snake is a contraption consisting of three PCIe cables, with the extra headers being cable-tied down out of the way. This is because you can't use the additional headers, unfortunately. It's the cleanest solution we could do without buying custom cables for our build. These PCIe cables then connect up to the graphics cards adapter, and then that runs into the front of the graphics card. If only this adapter was longer—we could then hide all of this mess out of the back.

14B

What's certainly needed is the GPU mount included with the case. This is a colossal card that puts significant strain on the motherboard. GPU sag would be inevitable, and we don't want to cause any damage by this. The mount attaches to the bottom of the case and can be adjusted by the thumb screw. Play around with this until it holds up the GPU with confidence. With the GPU firmly in place, it's time to insert all of the panels back in place. This includes the motherboard cover, RGB strip light, glass panels, and the back, side, door, and top panels. We also gave the back a tidy-up with some cable management using cable ties and the pre-installed velcro cable paths in the case.

15 A quick BIOS update

Hardware aside, we now need to get this system loaded up with our favorite applications. Before all the literal fun and games, we need to ensure we're running on the latest version of our BIOS so that the system performs



N7 B650E (1.12) BIOS Update
6.8 MB (x-zip-compressed)

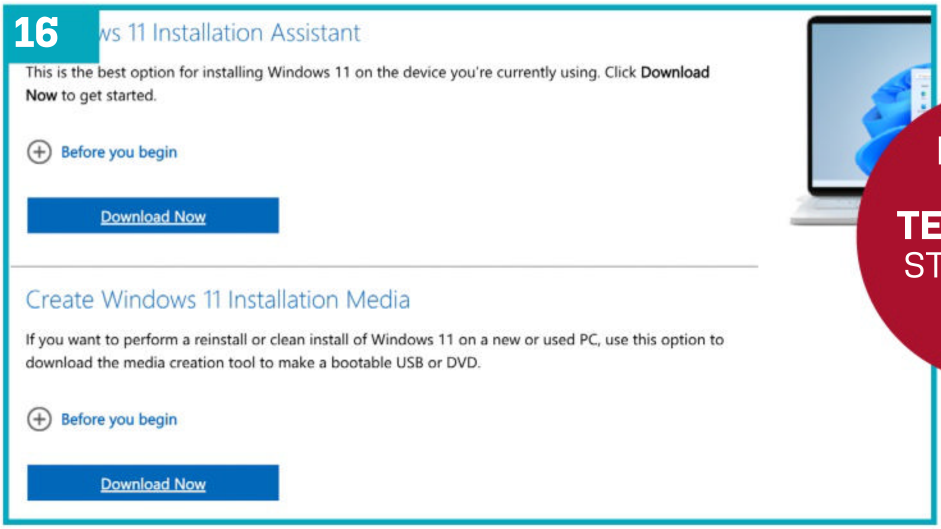
SATA Floppy Image Driver
783.1 kB (x-zip-compressed)

MediaTek WLAN Driver (v3.3.0.
11.4 MB (x-zip-compressed)

AMD-RAIDXpert2 Driver
87.5 MB (x-zip-compressed)

MediaTek Bluetooth (v1.930.0.2
2.3 MB (x-zip-compressed)

16



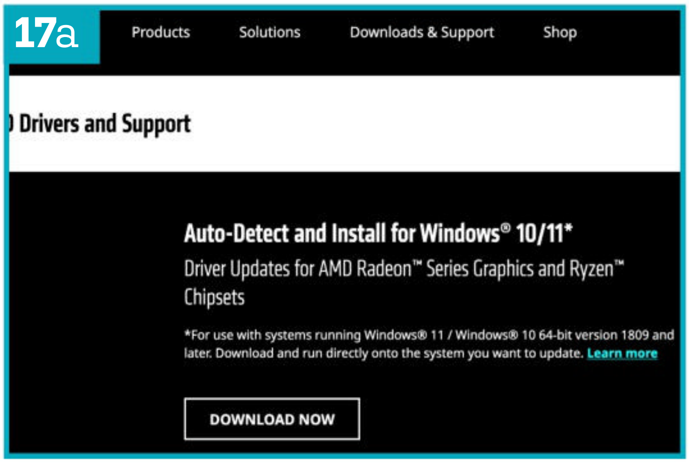
ws 11 Installation Assistant

This is the best option for installing Windows 11 on the device you're currently using. Click **Download Now** to get started.

Create Windows 11 Installation Media

If you want to perform a reinstall or clean install of Windows 11 on a new or used PC, use this option to download the media creation tool to make a bootable USB or DVD.

17a



Drivers and Support

Auto-Detect and Install for Windows® 10/11*

Driver Updates for AMD Radeon™ Series Graphics and Ryzen™ Chipsets

*For use with systems running Windows® 11 / Windows® 10 64-bit version 1809 and later. Download and run directly onto the system you want to update. Learn more

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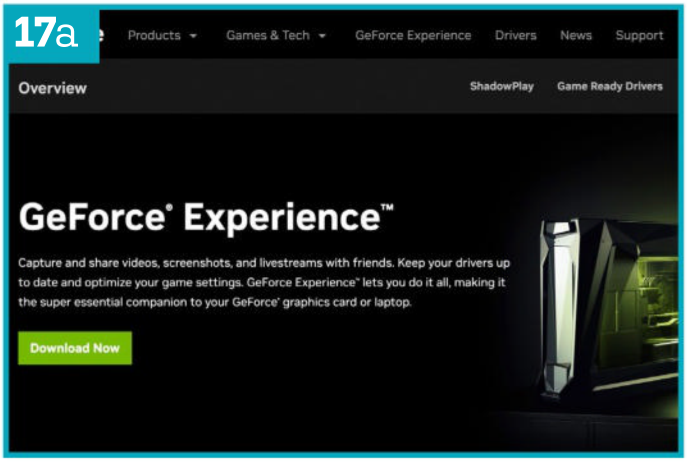


GeForce® Experience™

Capture and share videos, screenshots, and livestreams with friends. Keep your drivers up to date and optimize your game settings. GeForce Experience™ lets you do it all, making it the super essential companion to your GeForce® graphics card or laptop.

at its best. On another system, head to the motherboard manufacturer's official website and find the product page for your model. Here, under the support section, you should find the latest BIOS firmware. The easiest way to update a BIOS is the flashback method that our motherboard supports. First, you need to download and extract the file, then rename the BIOS file to "creative.rom" and move it onto a clean file formatted to FAT32.

All you then need to make sure is that the PSU has power, and without turning the system on, insert the USB drive into the "BIOS" port and press and hold the BIOS FLBK button for up to three seconds until the green light inside starts flashing. When the light stops flashing and it goes out, the BIOS update is complete.

16 You're going to need this

We aren't lying; without an operating system, you've essentially got a very expensive BIOS viewer, and trust us, there is only so much fun you can have there. For this, you are going to need another system again, and you can use the same USB drive used for the BIOS update so long as it's got at least 8GB of capacity and has been formatted clean again to FAT32. Now, head over to the official Microsoft Windows 11 download page and hit the download button under the 'Create Windows 11 Installation Media' section. Follow the onscreen instructions, and when it asks you where to install the OS, select your USB drive and continue.

After the installation has finished, you need to insert the drive into your new build PC and boot it up. At the BIOS, we need to re-arrange the boot order by putting the USB drive with the Windows 11 file at the top of the hierarchy, then save and exit to confirm this. When the system next boots, it will load into the Windows 11 installation wizard. Here, personalize to your liking, and then you're done. It's also worth installing all of the other latest drivers from your motherboard's product page under the support section, as this will help with overall stability.

17A These will help a bunch

To further improve stability and ensure the CPU and GPU are running at their best, we need to install the driver software for both. Starting with the AMD Ryzen 9 7950X3D, we need to install AMD's Auto-Detect and Install for Windows 10/11. Once downloaded, open it, and the application will automatically download all the latest drivers and chipsets for your system—just follow the onscreen installation wizard.

17B

As for our RTX 4090, we need to download Nvidia's GeForce Experience application. Open up the application and head to the top left of the screen, where you will see the 'driver' tab. Here, hit the 'check for updates" button and install the latest version. This is necessary to be able to properly use your graphics card, otherwise it's just an expensive ornament inside your PC. With all the necessary drivers installed, get straight over to the Steam website—we know you want to.

© NZXT, MICROSOFT, AMD, NVIDIA

A RYZEN 9 MASTERPIECE?

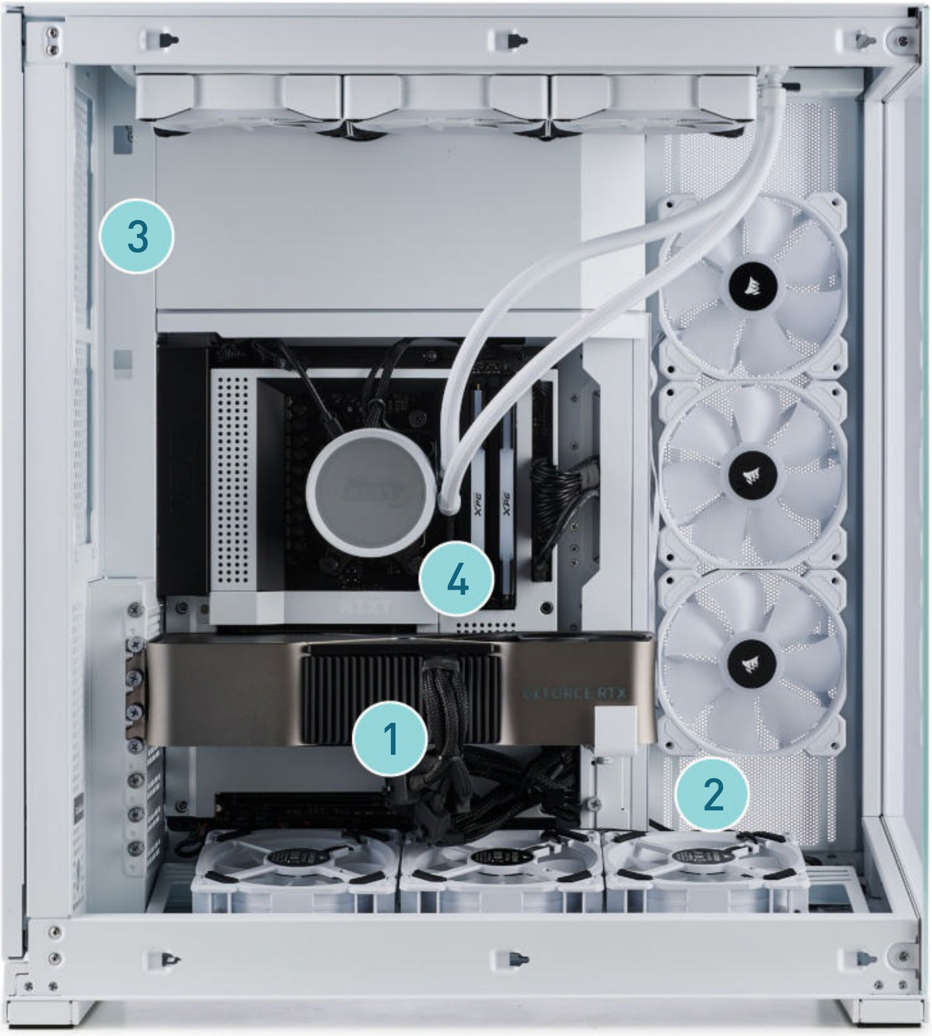
AT THIS STAGE, you're probably thinking that this build went pretty smoothly. Well, we are here to tell you that it didn't. Alright, we did resurrect it eventually, and the actual build went smoothly, but it wasn't until we tried to boot it up that we were left scratching our heads. When we only received a measly half-turn of the fans, we realized that something was wrong, and what felt like a lifetime of troubleshooting occurred.

This isn't our first rodeo, fortunately, so we went through the usual suspects of a failed-to-boot system. One of the first things we checked was if the cables were connected properly, so we looked at everything piece by piece, only to receive the same result. Next, we reseated the RAM, as this is a common failure point, but again this led nowhere. Our motherboard even had a dedicated power button, so we used this in case our power switch cable or header was faulty. You guessed it, this also led nowhere.

We assumed at this point that it was something to do with a potential overheating problem, as the system seemed to boot but then quickly turn itself off to prevent damage. Luckily, we had a spare stock AMD cooler to try out. This meant removing the NZXT CPU pump header, cleaning and repasting the CPU, and placing the stock bracket back on the board. With this on, we got a slightly longer boot, but the same old ending. For your information, all of these procedures were spaced apart by at least 10-minute intervals of pure confusion. It was a long day, but hey, it's all part of the process!

After this, we kept the stock cooler in and tried to run our system without the Corsair controller connected. We thought that maybe we were using too much power, as by default these fans will run at full throttle without BIOS or software tuning. By some sort of miracle, it booted up for slightly longer. Then we tried to boot it up with the Corsair Commander reconnected with another SATA cable, and it did boot. The issue was a faulty SATA cable. This was confirmed when we reinstalled the NZXT Kraken X73 cooler and the system booted. For us, it was a simple mistake of picking up an older SATA cable instead of the new one—they got bundled together. Don't underestimate the power of organizing your workstation.

We got there in the end, but not fully. Frustratingly, our bottom fans didn't light up, but did spin. We knew this was a simple fix by downloading the Corsair iCUE software, which we did, and this resolved the issue after the build.



1 Our main issue is the GPU PSU cables. We're missing one, so moving forward we will replace the PSU with one that has more PCIe ports.

2 An extra fan here along the front would have looked cleaner and filled the space more effectively.

3 More fans, you ask? Yes, we reply. An additional RGB exhaust fan here wouldn't make for a bad addition to the system.

4 Another set of the same kit would have finished this build off nicely and looked even better on the motherboard.

IS IT AS GOOD AS IT IS ON PAPER?

HECK YES, this machine is a monster when it comes down to performance, and after are few niggles, we're more than happy with how it turned out. Aesthetically too, especially with all of the RGB fans working, it's a very slick rig. Sure, a few custom cables would help to tidy it up some more, but overall we love how this ended up looking.

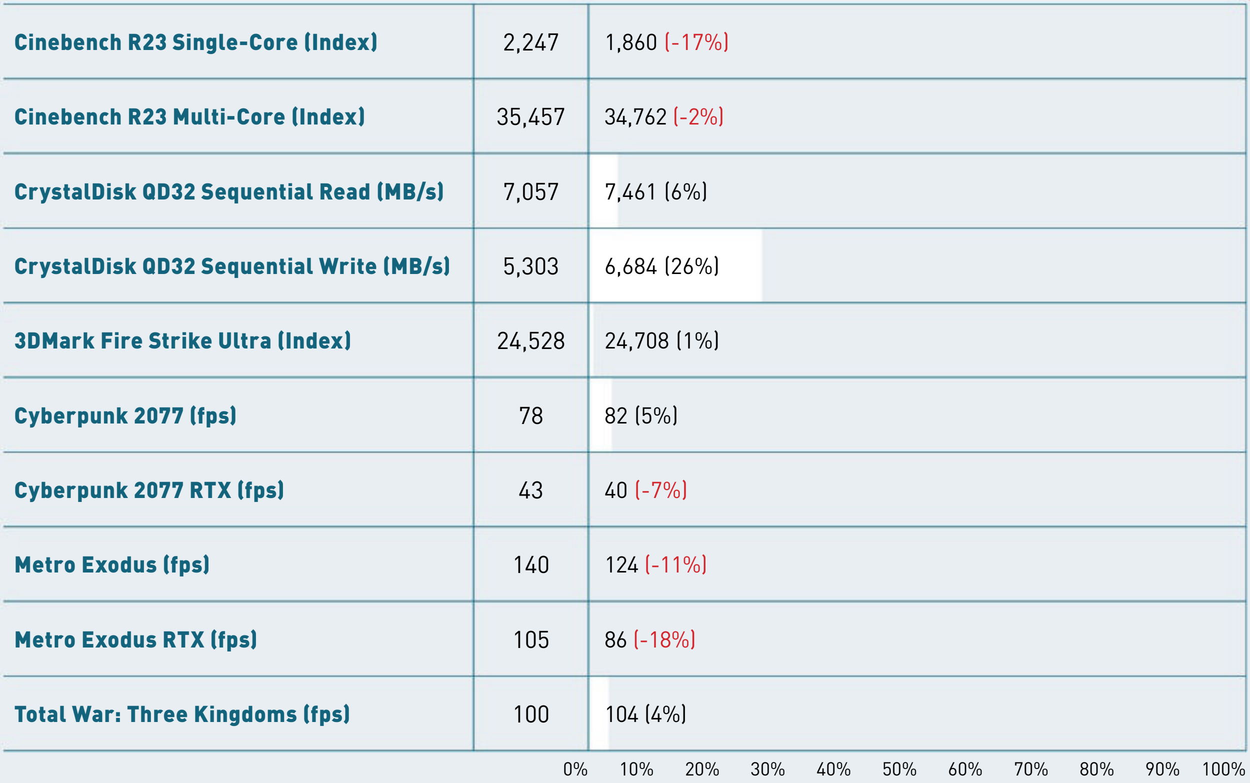
With everything cleared up, the only remaining restriction was that we were running our RTX 4090 on only three 8-pin PCIe cables, and not the full four 8-pin PCIe cables that it could use. If you have the choice, we obviously recommend using all four, as it means that you are getting all of the necessary power to your GPU, and it won't be restricted in any way, plus you could in theory try to overclock it. With only three, it limits the card to 450W, but with all four it goes up to 600W.

Regardless of this slight hindrance, our NVIDIA GeForce RTX 4090 Founders Edition card and the AMD Ryzen 9 7950X3D worked beautifully in unison. As you can see from our benchmark results compared to Guy's 8K gaming monster build with the Intel Core i9-13900K and the MSI GeForce RTX 4090 Gaming X Trio card (which has a slightly boosted clock speed over ours), the results were very close.

The most intriguing result for us was that our AMD Ryzen 9 7950X3D card fell slightly short on the Cinebench results. That's not to say that our results weren't fantastic, though. Another very similar result was the 3D Mark Fire Strike Ultra scores, with our machine beating its competitor by 1 percent—look, a victory is a victory. When it comes to outright gaming, both of these systems perform fantastically, there is no denying that. It was tight between both systems, with Guy's 8K gaming monster machine winning 4 out of the 6, but only marginally. We are talking about a difference of a few frames across the board.

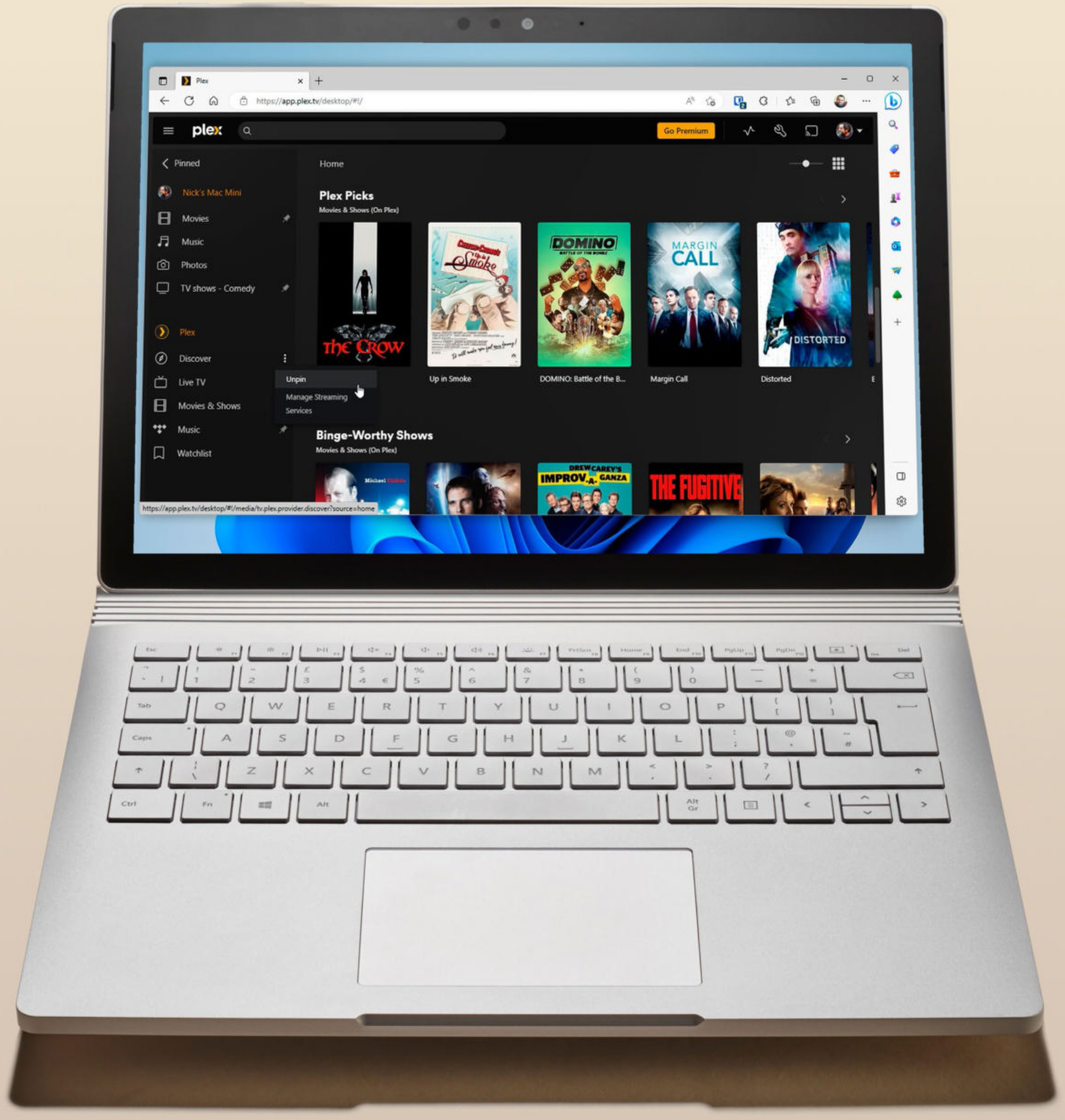
So for us, is the AMD Ryzen 9 7950X3D worth the additional cost of around $130 more than the Intel Core i9-13900K? Not really. Yet, that's throwing no shade at this Ryzen CPU—it's one heck of a behemoth, and with some slight overclocking, we managed to boost our results by up to 5 to 10fps. This AMD machine is brilliant, but then again at just under $4K it really should be, so at least it performs as it should. Whichever side of the fence you choose, both chips have more than enough longevity, and you will certainly not be disappointed by the results from either processor. ⏻

BENCHMARKS



	ZERO-POINT	
Cinebench R23 Single-Core (Index)	2,247	1,860 (-17%)
Cinebench R23 Multi-Core (Index)	35,457	34,762 (-2%)
CrystalDisk QD32 Sequential Read (MB/s)	7,057	7,461 (6%)
CrystalDisk QD32 Sequential Write (MB/s)	5,303	6,684 (26%)
3DMark Fire Strike Ultra (Index)	24,528	24,708 (1%)
Cyberpunk 2077 (fps)	78	82 (5%)
Cyberpunk 2077 RTX (fps)	43	40 (-7%)
Metro Exodus (fps)	140	124 (-11%)
Metro Exodus RTX (fps)	105	86 (-18%)
Total War: Three Kingdoms (fps)	100	104 (4%)

Our zero-point consists of the 8K Gaming Monster from our Holiday 2022 issue, featuring an Intel Core i9-13900K, MSI GeForce RTX 4090 GAMING X TRIO 24GB, Asus ROG Maximus Z790 Hero motherboard, 32GB (2x16) of Corsair Vengeance DDR5-5200, and 1TB PNY XLR8 CS3140 PCIe 4.0 M.2 SSD. All games tested at 4K 'Ultra' graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking.


Plex
https://app.plex.tv/desktop/#!/
Go Premium
Pinned
Nick's Mac Mini
Movies
Music
Photos
TV shows - Comedy
Plex
Discover
Live TV
Movies & Shows
Music
Watchlist
Unpin
Manage Streaming Services
Home
Plex Picks
Movies & Shows (On Plex)
Up in Smoke
DOMINO: Battle of the B...
Margin Call
Distorted
Binge-Worthy Shows
Movies & Shows (On Plex)
https://app.plex.tv/desktop/#!/media/tv.plex.provider.discover?source=home

You can easily remove Plex's own content by unpinning it.

© PLEX

BUILD A KILLER MEDIA SERVER

Nick Peers reveals how to take control of your media and build your own always-on streaming library

WHERE DO WE START with the problems of streaming services? Aside from the fact that they've proliferated in recent years as content increasingly gets siloed behind another expensive paywall, there's no guarantee that the show you're watching today will be available to stream tomorrow, never mind in the months ahead as complicated license rights shift from one platform to another.

The solution—as it always is—lies in owning your own content. Thanks to media servers like Plex and Jellyfin, you can make your own media library as accessible and easy to stream as any subscription-based streamer, with your content on tap 24-7 wherever you happen to be, and on whatever device you have to hand.

On the surface, setting up your media server is quite simple, but there are some considerations you need to make about where you host your server, plus how you package your content so it's easily playable. In this feature, we'll not only show you how to quickly set up and populate your own Plex server, we'll reveal the tips and tricks you need to ensure your content streams on any device without bringing your server grinding to a halt. Turn the page to find out how.

LET'S START with a quick examination of the hardware you're planning to use for your media server. While your main PC can effortlessly handle its relatively modest requirements, it's far more efficient to offload it to a low-powered device—one that can run 24-7 without racking up huge electricity bills. Once again, we point you towards our mini-NAS build from the September 2022 issue, but you could also use an old laptop that has been gathering dust somewhere.

In terms of hardware requirements, your media server must handle the organization of your library, plus distribute media streams to whichever devices require it. If you live in a big household or share your library with others, you might find it having to handle as many as 4-5 streams simultaneously on occasion.

How much effort each stream requires depends on the media file, and whether it's compatible with the playback device. The box reveals the different ways your media server can stream files, from the golden standard of 'direct play' to 'transcoding', where the file has to be converted on the fly to make it compatible.

In an ideal world, transcodes are few and far between—if you follow our advice later in this feature, you'll produce video and audio files that should direct-play on most devices. However, even when an apparently perfect file is being served up, there may be times when transcoding is required, often as a result of available network or internet bandwidth.

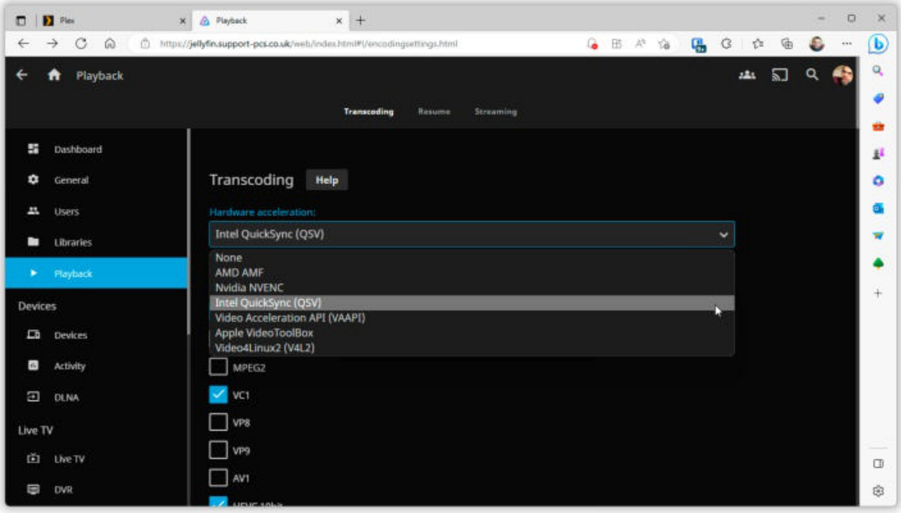
In these circumstances, a low-powered CPU like the Pentium J4125B or J5040 may struggle with two or more simultaneous transcodes. However, there's a potential ace up your processor's sleeve in the form of its GPU. Transcoding can be offloaded to the GPU, which makes short work of the task and allows you to perform many more transcodes without bringing your server grinding to a halt. You don't need a top-end GPU—for example, Intel's onboard graphics have long featured support for hardware transcoding through 'Quick Sync Video'. However, while QSV has been available since the days of Sandy Bridge processors, good-quality hardware transcodes didn't appear until 2016, and the emergence of processors sporting HD Graphics 600 or later. The equivalent technologies for other manufacturers are NVENC for NVIDIA (again, later generations—Turing onwards—produce better results), and AMF for AMD.

There's one fly in the ointment: the free version of Plex doesn't support GPU transcoding, so if you are planning to share your server widely, you'll need to consider investing in the Plex Pass. GPU transcoding is just one of many features hidden behind a paywall. These include access from a mobile device (you can, however, pay a one-off fee for the mobile app if you prefer), the ability to watch and record live TV through your Plex server, and lots of little benefits, like access to historic stats on the Plex Dashboard, so you don't just see who's currently playing content on your server, but have access to stats revealing what's been watched, by whom, and when.

A Plex Pass costs $4.99 a month, $39.99 a year, or $119.99 for a lifetime license. If this is too high for you, the good news is that the vast bulk of features locked behind the Plex paywall—including GPU transcoding—are available for free to Jellyfin users.

PRE-SETUP STEPS

Before installing your media server, it pays to get your files organized correctly so your server can easily



Hardware acceleration:
Intel QuickSync (QSV)

None
AMD AMF
Nvidia NVENC
Intel QuickSync (QSV)
Video Acceleration API (VAAPI)
Apple VideoToolBox
Video4Linux2 (V4L2)

☐ MPEG2
☑ VC1
☐ VP8
☐ VP9
☐ AV1

Jellyfin supports hardware transcoding without requiring a subscription.

© PLEX

TRANSCODING VERSUS DIRECT STREAMING

When you stream media from one device to another, the receiving device must be capable of playing the media file in question. That means it needs to recognize four things about the file: its format or 'container' (such as MKV or MP4 for video); bitrate (the number of bits being transferred per second); resolution (such as full 1080p HD or 4K), and the codecs used to encode—and subsequently decode—the file's video and audio streams (such as H.264 for video, and AAC for audio).

When the receiving device recognizes all four of these, it's able to "direct play" the file in question. This means all your server must do is send the file to the device, which costs its practically nothing in CPU and RAM resources. If it recognizes the bitrate, resolution, and codecs, but doesn't recognize the file container, then your server must 'remux' the file, which basically involves extracting the audio and video streams and repackaging them into a compatible container. This is known as "direct streaming", and again requires few system resources.

If the codecs, resolution, or bitrate isn't supported by your receiving device, or

identify them, then pull in all the metadata and artwork needed to provide you with a beautiful media-browsing experience. The following examples reveal the basics of naming and organizing movies, TV shows, music, and music videos into folders so that they appear perfectly in Plex (and to a large extent, Jellyfin too).

\Movie title (year)\Movie title (year).mp4

\TV Show\Season 1\TV Show Name—S01E01—Episode title.mp4

\Artist Name\Album Cover\01-Track Name.mp3

\Artist Name\Album Cover\01-Track Name-video.mp4

This merely scratches the surface of what's possible—Plex provides a link when setting up your libraries to provide you with a more detailed explanation of what's possible (including supplements—deleted scenes, trailers, behind-the-scenes featurettes—alongside your movies and TV shows), but also check out our December 2022 tutorial on naming and organizing your libraries with the help of such tools as Rename My TV Series (www.tweaking4all.com/home-theatre/rename-my-tv-series-v2/) and MetaX (www.danhinsley.com).

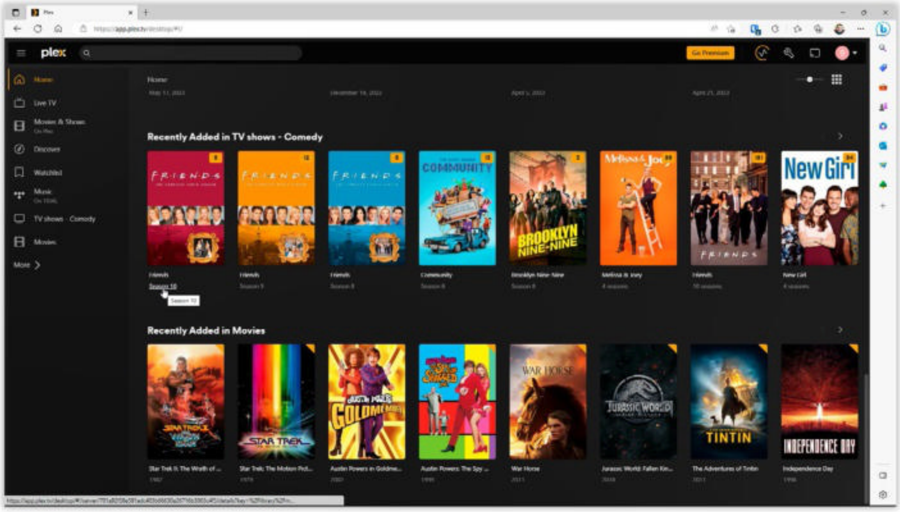
INSTALL YOUR MEDIA SERVER

Your hardware is ready, your media is properly organized, and you're itching to get started. It's time to pick your media server. There are plenty of choices, but as you'll have seen from our November 2022 head-to-head, our favorites by some stretch are the open-source Jellyfin (www.jellyfin.org) and the freemium Plex (www.plex.tv).

We're focusing on Plex in this feature only because we covered Jellyfin back in the Holiday 2020 issue, but the steps for both are similar, and even if you don't have that issue to hand, you'll find most of what we cover here can be translated to Jellyfin. Even better, if you love Plex's user-friendliness and slick interface, but want to give others access to more advanced features like GPU transcoding and live TV support without shelling out for a Plex Pass, you can install both side-by-side, and keep Plex for yourself while sharing your Jellyfin server far and wide.

Plex users should head to www.plex.tv/media-server-downloads/ to download server installers for Windows, macOS and Linux (as well as other platforms like Synology and QNAP), while Jellyfin users will find the required packages at https://jellyfin.org/downloads/server for Windows, macOS, Linux, and Docker (including instructions for those installing through the command line).

Once installed, both the initial configuration and day-to-day running of your server will be done through your web browser. In the case of Plex, you'll be automatically redirected to https://app.plex.tv, where you'll be prompted to sign into your Plex account—if you've not yet created one, simply choose your method of signup (Google, Facebook, Apple, or regular email), and follow the prompts.



Once removed, your own media is displayed front and center.

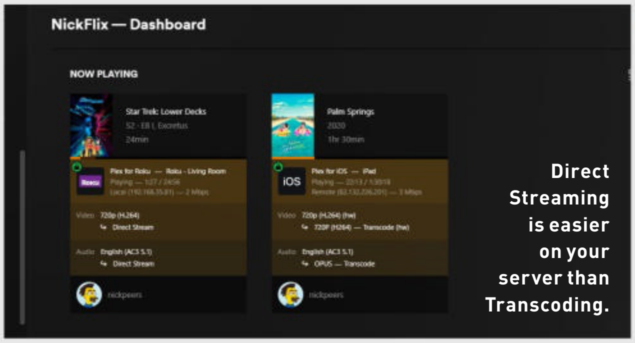
INITIAL STEPS

The server setup screen starts by asking you to select your favorite streaming services, which you can integrate into your Plex home view if you wish, or simply close the box to skip. You'll also be prompted to sync your watch state and ratings across the entire Plex platform (so not just your server, but others, too). A short summary of how Plex works will be displayed—click 'Got It!' to find yourself at a simple three-step wizard.

Step one prompts you to name your server, plus offers a check box marked 'Allow me to access my media outside my home'. Click Next to be prompted to set up

your media's bitrate exceeds your internet upload speed, then your media server will 'transcode' the file. This requires it to extract all the various components and re-encode them on the fly into a format that is compatible with your target device and will stream over the available internet connection.

There are two types of transcoding: software requires more CPU resources, and can quickly grind low-powered servers to a halt if two or more streams are transcoded simultaneously, while hardware transcoding offloads much of the work to a suitably powered GPU (see main copy for recommendations). The difference is phenomenal—and on a server that performs multiple functions, hardware transcoding is a must.



NickFlix — Dashboard

NOW PLAYING

Star Trek: Lower Decks

Plex for Roku — Roku - Living Room

Video 720p (H.264)
↳ Direct Stream

Audio English (AC3 5.1)
↳ Direct Stream

nickpeers

Palm Springs

2020

1hr 30min

Plex for iOS — iPad

Video 720p (H.264) (hw)
↳ 720P (H.264) — Transcode (hw)

Audio English (AC3 5.1)
↳ OPUS — Transcode

nickpeers

Direct Streaming is easier on your server than Transcoding.

your media libraries. Plex should automatically pre-select your personal music and pictures libraries, which you can edit or remove from here, then click 'Add Library' to set up your first library. You'll be given a choice of five library types: Movies, TV Shows, Music (including Music Videos), Photos, and Other Videos, all of which are largely self-explanatory.

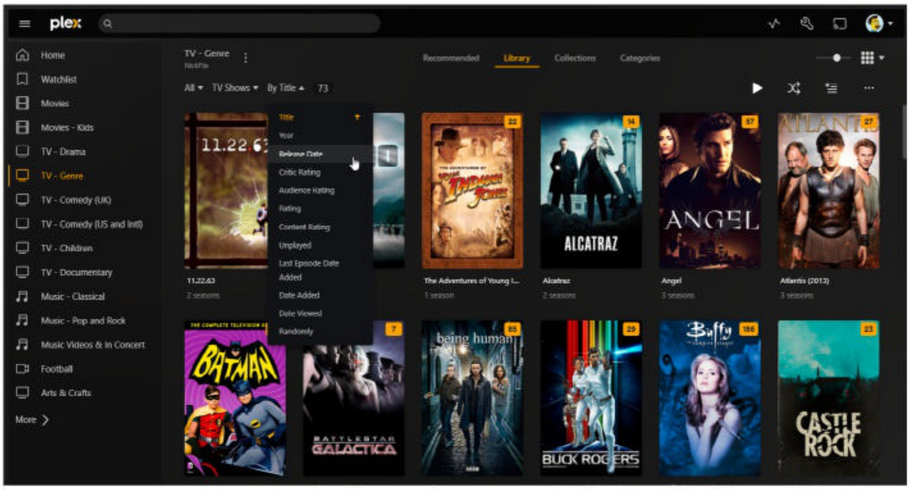
(Note, you're not restricted to a single library for each type of content—you could split your pop and classical music collections into separate libraries, for example, or divide your TV between drama, documentaries, and comedy. Just make sure each library's content is housed in its own folder.)

Once selected, name your library and click Next, followed by 'Browse for Media Folder' to select your library's content. You can group multiple folders into a single library, but if you've followed our advice, you'll have already consolidated your folders. Once you're done, click 'Add Library'.

From here, it's a case of clicking Next to be given a link to the apps you'll need to access your Plex server's content, with computers, consoles, mobile devices, streaming sticks, and smart TVs all covered (you can also play content directly from your web browser through the Plex server interface). Finally, click Done to find yourself at your Plex home screen.

CUSTOMIZE HOME SCREEN

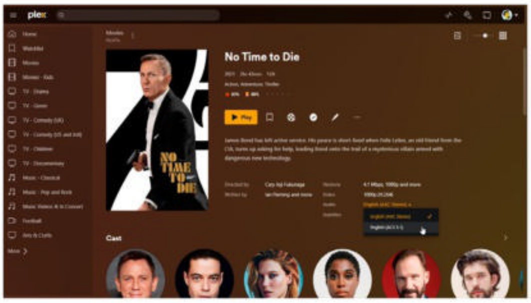
This screen is replicated across all your playback devices, although each device can be customized individually. On the left is a list of categories—you'll notice that Plex mixes your own libraries in with its own free streaming libraries, as well as any third-party streamers you may have added.


plex
Home
Watchlist
Movies
Movies - Kids
TV - Drama
TV - Genre
TV - Comedy (UK)
TV - Comedy (US and Intl)
TV - Children
TV - Documentary
Music - Classical
Music - Pop and Rock
Music Videos & In Concert
Football
Arts & Crafts
More
TV - Genre
Recommended
Library
Collections
Categories
All
TV Shows
By Title
73
Title
Year
Release Date
Critic Rating
Audience Rating
Rating
Content Rating
Unplayed
Last Episode Date Added
Date Added
Date Viewed
Randomly
11.22.63
The Adventures of Young I...
Alcatraz
Angel
Atlantis (2013)

Plex offers many ways to view and filter your content.

You'll need to scroll down to the bottom to find any evidence of your own libraries—the spinning circle at the top of the screen indicates Plex is scouring your libraries looking for content, and the 'Recently Added' section will update as new content is found and added. While you wait for this process to complete, let's look to customize that home screen.

Roll your mouse over any of the categories in the left-hand pane to reveal a vertical ellipsis (⋮)—click this to reveal a drop-down menu. Remove unwanted elements from the home screen by choosing 'Unpin' or select 'Reorder' to move items up and down the list using drag-and-drop (click X next to Reorder when you're done). If you have no interest in any of Plex's own content, simply unpin everything except your own libraries—unpinned content isn't removed, and can still be accessed by clicking the More button followed by the item you're interested in.


plex
No Time to Die
Play
Cast

Plex pulls all its media info from a variety of online sources.

© PLEX

BROWSE AND PLAY MEDIA

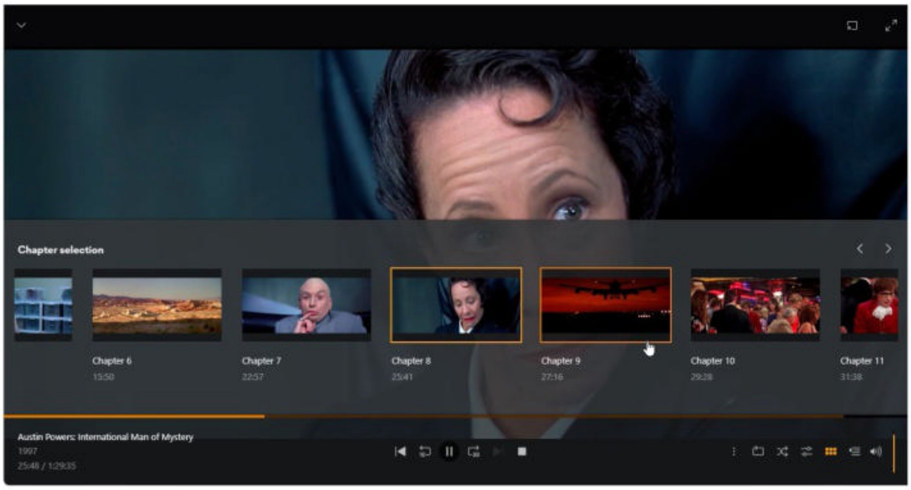
The home screen is configured to display recently added items to your libraries—it'll also eventually display a 'Continue Watching' segment at the top—this is where the shows and movies you're watching appear, allowing you to easily resume partially finished movies or access the next episode of a TV series you're bingeing.

Roll your mouse over an item's artwork, and you'll see a convenient play button—clicking this will play the movie. Alternatively, click a library's title in the left-hand pane to go to its own home page. You'll be presented with a similar

FINE-TUNE YOUR LIBRARY

You can make all kinds of changes to your library—simply roll your mouse over a title's artwork in library view and click the pencil icon to edit anything you like about it—the title name and synopsis, tags, poster, and background image can all easily be changed here. And what happens on those rare occasions when Plex misidentifies a movie or TV show? Roll your mouse over the artwork again, but this time click the vertical ellipsis button, where you'll find loads more controls, including a 'Fix Match…' option. This allows you to search for the correct item using its title and year. Once selected, Plex will update its metadata accordingly.

As your library grows, you may want to explore other ways of organizing things—for example, you can create collections that allow you to group related movies (say, all the Marvel Cinematic Universe movies) together for easy access. To do this, click the circle in the top-left corner of an item's artwork to check it for selection. Repeat for the other movies in your series, then click the pencil (edit) button that appears at the top of the library. Select Tags from the left-hand pane,



You can skip through a video several ways.

view to the Home screen—this 'Recommended' view is Plex's way of directing you to what it considers interesting content. Next to 'Recommended' is 'Library'—click this for an A-Z list of all that's library's content, complete with numerous filters and tools for customizing the view. Take the time to familiarize yourself with how everything works—if there's one thing Plex is, it's flexible when it comes to your library.

Select an individual item, and you'll be whisked to its own screen, where you'll see lots of useful information—for example, movies will list a synopsis, cast members, reviews, and other related content. Click a person's name to view all available content within your Plex library in which that person is credited—just click to jump to it.

The movie's screen also displays technical information: the video (resolution and codec), audio (language, number of channels, and codec), and subtitles. If the file has multiple audio tracks, you can select a different one via the Audio dropdown menu before playback, and the same is true for subtitles if they're embedded. If they're not, click 'None' to search the internet for a track, or to upload your own.

Once you start playing a file, you'll see playback controls appear at the bottom of the screen, allowing you to navigate around the title quickly and easily. Pay particular attention to the controls on the bottom right of the screen, where you can move effortlessly between chapters and—via the Settings—video, audio, and subtitles tracks (plus the option to change how the subtitles are displayed). Spend a few minutes exploring these options, and for more library management tips, check out the 'Fine Tune Your Library' box.

TAKE A DEEPER DIVE

You're well on the way to mastering the basics of administering your Plex server, but before we leave you to explore on your own, click the spanner icon at the top of the screen to access your server's settings. Work your way through the list from top to bottom—areas of interest include 'Plex Home' under your account name.

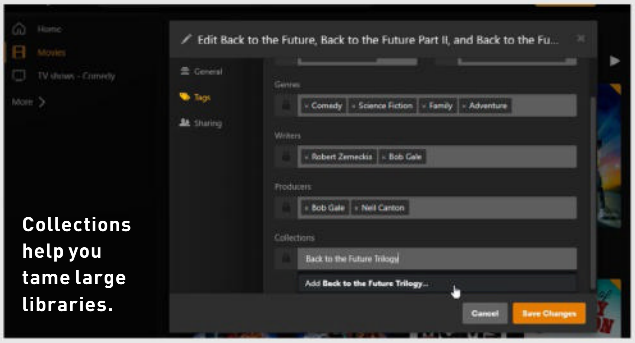
If you share your Plex server with other members of your household, you can create managed accounts for each person here, allowing them to watch their own content (including building their own On Deck playlists) while giving you the opportunity to restrict access to specific libraries or content based on their age. Each account can also be protected via a four-digit PIN. If you'd like to give outside users access to your Plex server, move on to 'Manage Library Access', where you can invite them to connect through their own Plex account.

When it comes to accessing Plex from outside your home, check the Settings under Plex Web. By default, any internet streams are limited to 720p with 2Mbps bitrate, which likely means transcoding. If you think your internet connection's upload speed can handle it, try a higher setting (say 4 Mbps 720p or 8 Mbps 1080p), or check 'Automatically adjust quality (Beta)' to allow Plex to scale up or down as your bandwidth allows.

Most of the other options are largely self-explanatory—consider limiting the number of maximum simultaneous transcodes under Transcoder to 2-4 depending on your server's hardware capabilities. Also, explore Optimized Versions, where you'll find an option to transcode movies to streaming-friendly formats ahead of watching them. This will basically create a copy of the movie that sits alongside the original, and is a good way to reduce the load on your server if you, say, plan to travel and know in advance what you'd like to watch on the road.

scroll down, and you'll see an empty Collections field. Type the name of your collection here, and then click 'Add <Collection Name>...' beneath it to create the tag.

When you click Save Changes, a new collection will appear alongside the movies themselves. If you'd like to tidy your library by hiding the movies from separate view, you need to click the vertical ellipsis next to the library name in the left-hand pane and choose 'Manage Library > Edit...' Select Advanced, scroll down to the bottom of the list of options, and change the Collections dropdown to 'Hide items which are in collections', followed by Save Changes. Now, only the collection will appear—click this to access the individual movies from the collection's own screen.



Edit Back to the Future, Back to the Future Part II, and Back to the Fu...

Genres: Comedy, Science Fiction, Family, Adventure

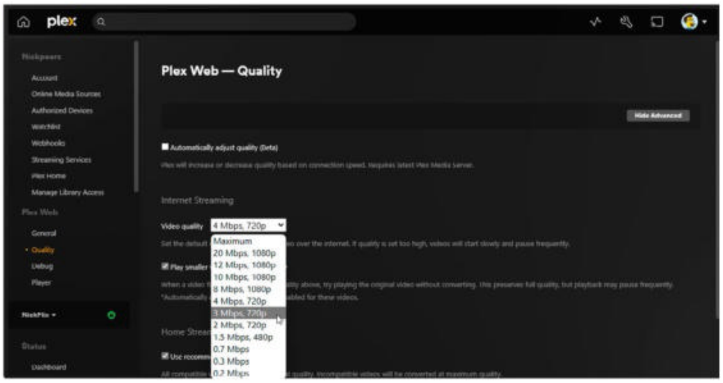
Writers: Robert Zemeckis, Bob Gale

Producers: Bob Gale, Neil Canton

Collections: Back to the Future Trilogy

Add **Back to the Future Trilogy...**

Collections help you tame large libraries.



Plex Web — Quality

☐ Automatically adjust quality (Beta)

Internet Streaming

Video quality: 4 Mbps, 720p

plex
Account
Online Media Sources
Authorized Devices
Watchlist
Webhooks
Streaming Services
Plex Home
Manage Library Access
Plex Web
General
Quality
Debug
Player
Status
Dashboard
Hide Advanced
Maximum
20 Mbps, 1080p
12 Mbps, 1080p
10 Mbps, 1080p
8 Mbps, 1080p
4 Mbps, 720p
3 Mbps, 720p
2 Mbps, 720p
1.5 Mbps, 480p
0.7 Mbps
0.3 Mbps
0.2 Mbps
Home Streaming

Set a streaming bitrate appropriate to your internet connection.

Congratulations: your media library is set up, and you're now able to enjoy it whenever and wherever you happen to be! All that remains is to ensure your media is in the best possible shape to minimize the need for transcoding.

OPTIMIZE YOUR MEDIA

If you're struggling to get certain media files to play through your server, or looking for a best-practice guide to encoding your movies and shows in a format that will play on the widest variety of devices, you'll need the following software tools. First, extract files from optical disc using MakeMKV (www.makemkv.com), which produces an uncompressed copy of your files in a format you can feed through the brilliant open-source Handbrake (www.handbrake.fr) video encoding tool.

MakeMKV is incredibly easy to use—launch the program, pop the disc into the drive, and click the drive icon to scan the DVD or Blu-ray for content. This will be presented to you as a list with file sizes. Select a title to reveal more information, such as its running time, which helps you identify it (along with anything else on the disc, such as special features—use a site like blu-ray.com to help match titles by their length).

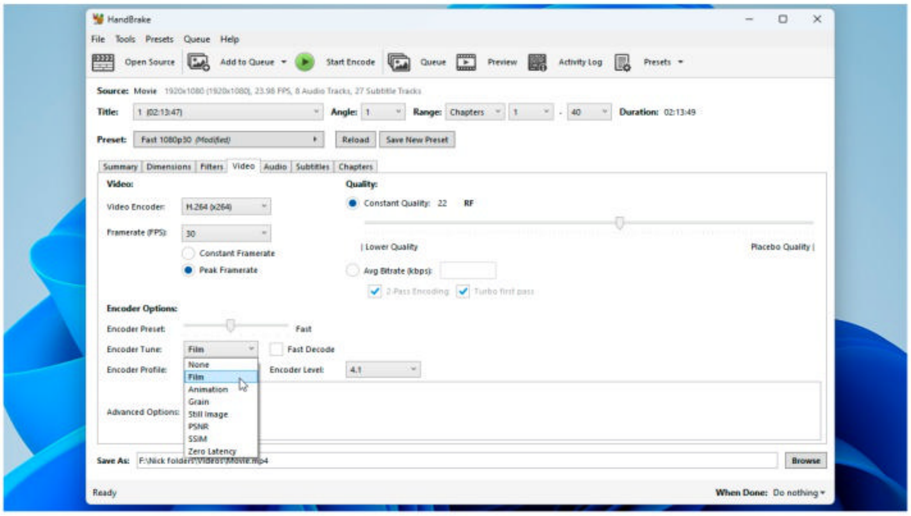
Once you've ripped the uncompressed files to your hard drive and renamed them, launch Handbrake and select your source: typically a folder full of the files you ripped. They'll be listed under the Title dropdown menu. Beneath this is a Preset dropdown list—these contain a library of frequently used settings, but we're going to show you how to quickly build a preset for HD movies using the options offered across a series of tabs.

Start with the Summary tab: by default, MP4 is selected as the output file. Make sure 'Web Optimized', 'Align A/V Start' and 'Passthru Common Metadata' are all ticked. Next, switch to the Dimensions tab. You should see the storage dimensions are set correctly to 1920x1080. However, if you need to lower this, use the 'Resolution Limit' dropdown to select 720p HD.

You'll also see that Handbrake is set to automatically crop the image—this should remove any black bars at the top and bottom of the video to help reduce the file size, but Handbrake can be overzealous, so set 'Cropping' to None, then switch back to the Summary tab and cycle through the Source Preview thumbnail images to see if any black bars return. If they do, set 'Cropping' back to Automatic or Conservative, then check again.

Skip the Filters tab—this is primarily for lower, non-HD

Use Handbrake's Video tab to balance file size versus image quality.



Source: Movie 1920x1080 (1920x1080), 23.98 FPS, 8 Audio Tracks, 27 Subtitle Tracks

Title: 1 (02:13:47) Angle: 1 Range: Chapters 1 - 40 Duration: 02:13:49

Preset: Fast 1080p30 (Modified)

Video Encoder: H.264 (x264)

Framerate (FPS): 30

○ Constant Framerate

● Peak Framerate

● Constant Quality: 22 RF

○ Avg Bitrate (kbps):

☑ 2-Pass Encoding ☑ Turbo first pass

Encoder Preset: Fast

Encoder Tune: Film

☐ Fast Decode

Encoder Level: 4.1

Save As: F:\Nick folders\Videos\Movie.mp4

When Done: Do nothing

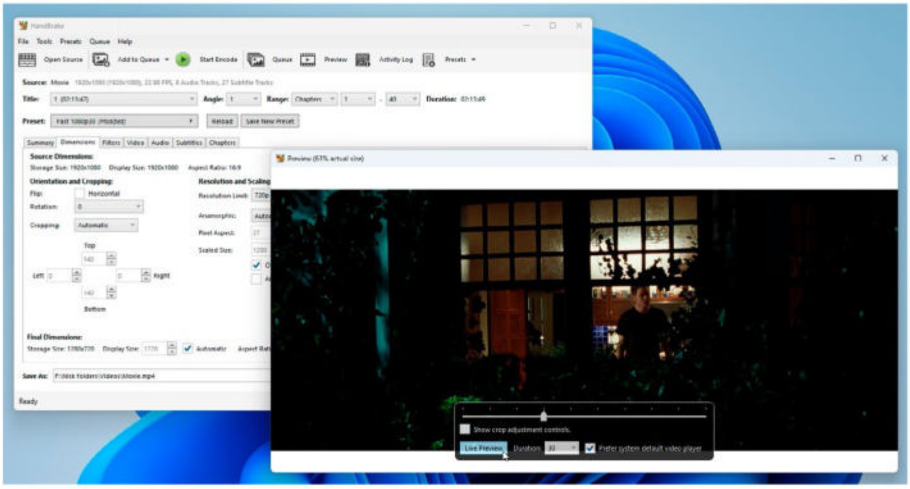
HandBrake
File
Tools
Presets
Queue
Help
Open Source
Add to Queue
Start Encode
Queue
Preview
Activity Log
Presets
Reload
Save New Preset
Summary
Dimensions
Filters
Video
Audio
Subtitles
Chapters
Video:
Quality:
Lower Quality
Placebo Quality
Encoder Options:
Encoder Profile:
Advanced Options:
None
Film
Animation
Grain
Still Image
PSNR
SSIM
Zero Latency
Browse
Ready

© PLEX, HANDBRAKE

SONIC PERFECTION

While audio transcoding isn't as CPU-intensive as video transcoding, it's still a good idea to maximize compatibility where you can. When it comes to configuring your audio streams, we recommend using the AAC (avcodec) for any stereo tracks, and AC3 for any surround-sound tracks. Between them, AAC and AC3 should offer at least one track that direct-plays on any playback device. If there's only a single stereo track, simply create a single AAC (avcodec) track; if there's only a single surround-sound track, however, create two audio streams from it—one downmixed to stereo (AAC), and the other preserving the 5.1 surround sound mix (AC3).

The other consideration is bitrate, which ultimately determines the quality of the audio stream: again, your personal preference will determine this, but as always, the higher the bitrate, the larger your file. Consider settings 224 kbps for your stereo track, and 448 kbps for your surround-sound track. Note, if there's an input AC3 448 kbps surround-sound track, consider choosing 'AC3 Passthru', but only after listening to the track to verify


HandBrake
File Tools Presets Queue Help
Open Source
Add to Queue
Start Encode
Queue
Preview
Activity Log
Presets
Summary
Dimensions
Filters
Video
Audio
Subtitles
Chapters
Preview (67% actual size)
Show crop adjustment controls.
Live Preview
Duration
Prefer system default video player
Ready

See how your tweaks work using Handbrake's live preview.

resolutions sourced from analogue material—and go to the Video tab, where you should verify 'Video Encoder' is set to H.264 (x264), the FPS is set to 'Same as source' and that 'Variable framerate' is selected. Use the 'Encoder Tune' dropdown under Encoder Options to optimize the encoder based on the source material: typically Film or Animation, but Grain may be a good choice for some older video sources. For HD content, make sure the Encoder Profile is set to 'High' and the Encoder Level is '4.1'.

Finally, you'll see that a Constant Quality slider has been selected—you can experiment with pushing the slider one or two notches to the left to reduce file size without impacting too much on quality, but like all the settings on this tab, you'll want to experiment using the live preview to find your sweet spot between file size and quality.

AUDIO SETTINGS

The next tab is where you set up your audio streams. MP4 files can contain multiple audio streams, allowing you to create different mixes (say, bog-standard stereo and a surround-sound track), and even include extras like director commentaries. On the far left are details of the input audio stream: language (codec) (number of channels) (bitrate—if applicable). To the right of this are the options for determining your output audio stream.

You'll notice that a wide range of codecs are supported—including passthru options for the original input codec. However, this comes at a cost of inflating the file size, and would force Plex to transcode the track on any non-compatible audio devices. For advice on the best codecs to choose, see the Sonic Perfection box.

FINAL TWEAKS

Once your audio track(s) have been set up, switch to the Subtitles tab to add any required subtitle tracks. It's all reasonably self-explanatory, but note that if 'Burn in' is grayed out, it means the subtitle track will be automatically burned into the video stream (common with HD movies)—remove the subtitle track if this is the case, and instead use Plex's search tools to find a suitable track to import into your library.

If the movie contains passages of non-English dialog, check the original video to see if the subtitles are already present on the video stream; if they aren't, try the 'Foreign Audio Scan' option (make sure 'Forced Only' and 'Burn In' are both ticked). If this doesn't yield any results, you'll need to manually go through the list of available subtitle tracks—you should find at least one additional English language track is provided, which contains those missing subtitles (again, play the video through VLC, and experiment with the different subtitle tracks to find the right one). Once located, add it via the 'Tracks > Add New Track' button, and check 'Burn In' to ensure it's added.

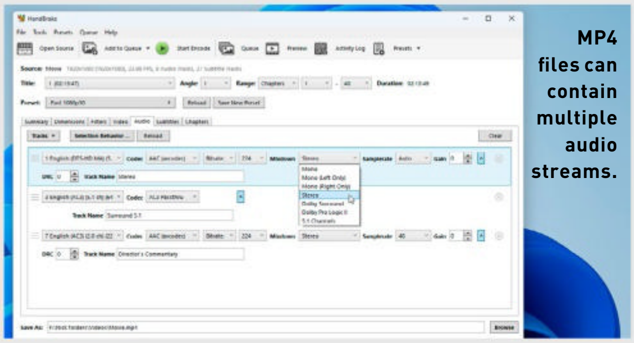
The final tab is Chapters, and provides you with the opportunity to rename chapters if you wish. Unlike audio track (and subtitle) names, anything you enter here is displayed within Plex and Jellyfin when navigating using chapters.

TEST, THEN RIP

Everything's configured to perfection, so time to rip, right? Not quite. It pays to test your settings, which is done by clicking Preview to bring up a series of thumbnails and the option to create a live preview of 30 seconds (you can extend this up to 240 using the dropdown menu). If you're satisfied, you can go ahead and click 'Start Encode' or 'Add to Queue' to process multiple titles at once. Once your rip is complete, you'll have an MP4 file that should play across a wide range of devices through Plex (and Jellyfin).

that it's not a commentary or audio descriptive track.

One final thing: each audio track is named for the number of channels provided by the input stream, so even if you downmix a 5.1 surround-sound track to stereo, it'll still be named 'Surround Sound 5.1'. This isn't important to Plex and Jellyfin—they simply list each audio track by its codec and the number of channels it contains, but playback in other players including VLC will unhelpfully list the stereo track by its incorrect name: 'Surround Sound 5.1'. If you're a perfectionist or want to have the correct name in place (including commentary tracks) in case either media server offers the option of viewing the track name in future, then click the ▯ button to the right of the track to rename it.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MP4 files can contain multiple audio streams.

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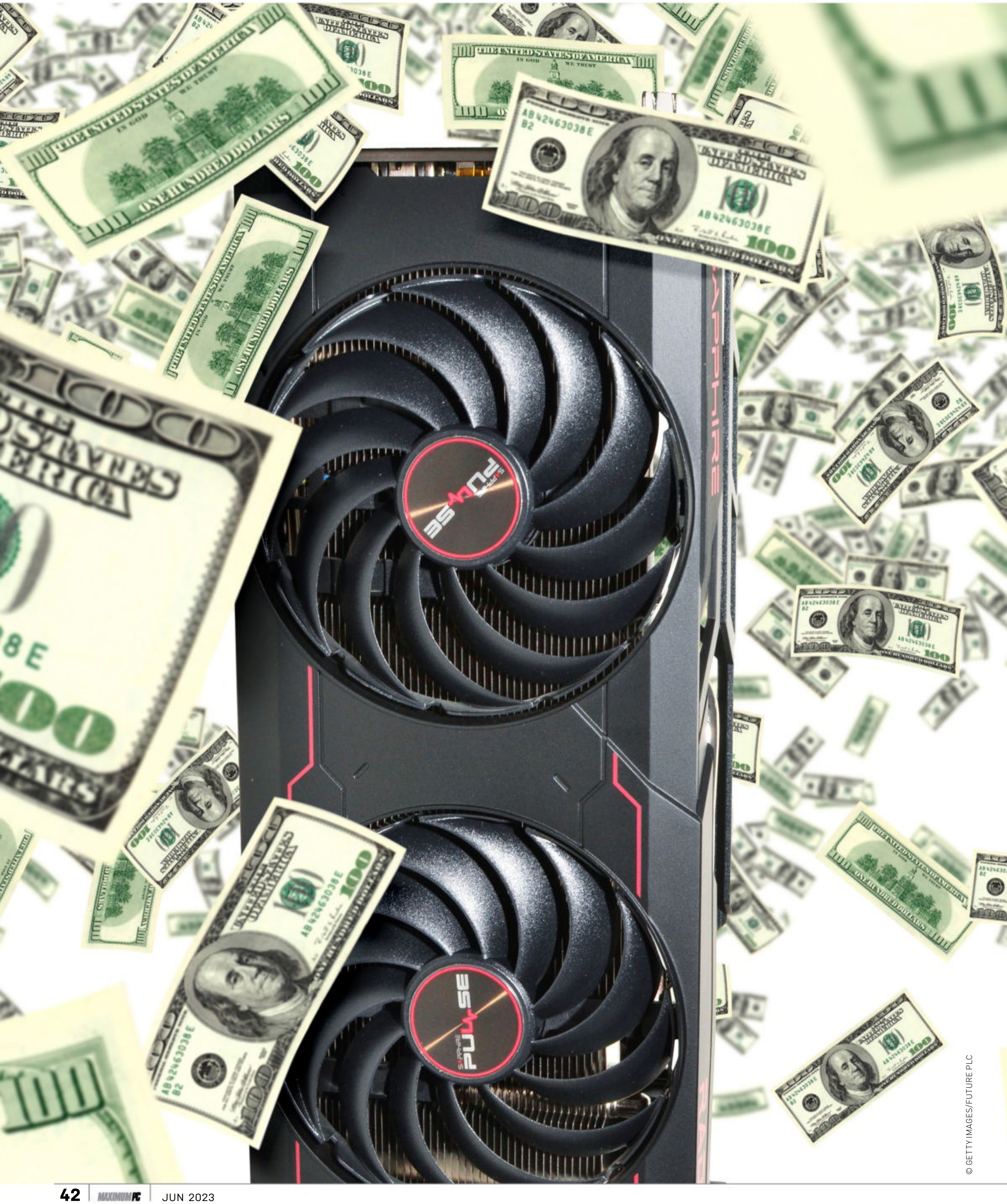

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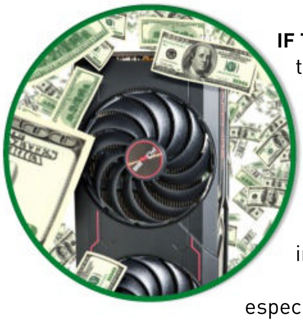
THE GREAT GRAPHICS CARD BUBBLE

GPU prices have been ridiculous for years. *Jeremy Laird* investigates how we got here and if we could return to "normal" pricing

Why, exactly, are graphics cards so expensive? With every new GPU launch comes the same refrain: nice card, shame about the price. Everyone seems to agree that PC graphics cost too much, so are $600 GPUs the new mainstream reality? Is there no going back on four-figure prices for higher-performing boards? Or is there hope for something approaching a return to what you might call historical pricing models?

The good news is that graphics card prices today are lower than they were 18 months ago. Back then, mid-range cards cost over $1,000, and anything remotely high-end was megabucks. But all that was a consequence of some once-in-a-generation factors, not least of which were the pandemic, a cryptocurrency craze, and a war in Europe.

But the impact of those events, on the graphics card market, at least, has largely—if not entirely—passed. But here we are in 2023, and certain GPU models are still priced at nearly double their immediate predecessors. So is this all just a long, painful hangover, and prices are trending back to historical norms? Or has something fundamentally changed in PC graphics?



IF THE QUESTION WE'RE ASKING HERE is what the heck is going on with GPU prices, the first and most obvious observation is that graphics cards are now outliers in the PC hardware market. The pandemic and war in Europe had very broad impacts on everything from supply chains to demand for stay-at-home technology, as well as inflation in a general sense.

Some of that influence is ongoing, especially currency inflation. But when it comes to PC hardware, it's mostly history. For proof, look no further than prices for all manner of components. Take SSDs. They're now cheaper than ever, with market research indicating that the cost of an SSD tumbled by around 15 percent in the first quarter of 2023 alone, with further falls predicted for the rest of the year. You can now get a fast 1TB SSD for about $50. A really high-spec 1TB drive is yours for under $100.

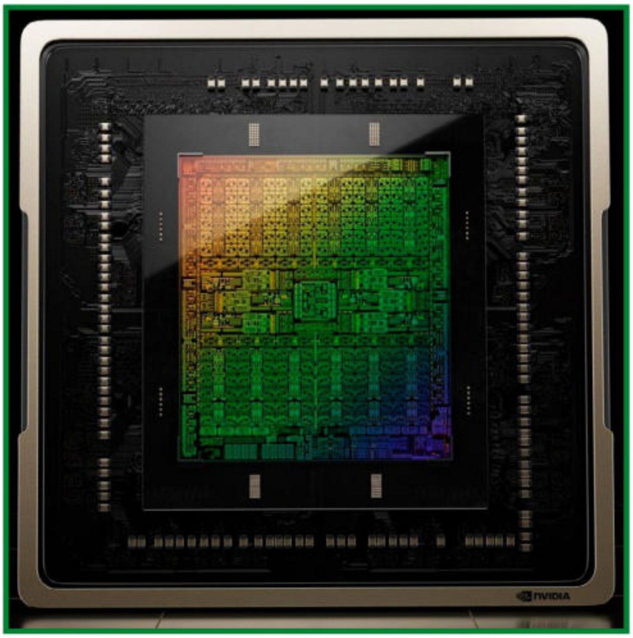
System memory—or RAM—has been going the same way. Even the latest DDR5 kits are now dirt cheap. 16GB for $50? No problem. In fact, pretty much everywhere you look, hardware prices have fallen back towards historic pre-pandemic trends. Okay, there are plenty of premium products out there. The new generation of OLED monitors looks pretty pricey, as do a lot of displays with mini-LED backlights. But you can also snag a 240Hz refresh 1080p monitor from a big brand for about $150.

For less than $250, you can upgrade to 1440p and 27 inches, and still with decent 165Hz refresh. Likewise, 4K 60Hz monitors for productivity are now so cheap, they're almost giving them away. Probably the most directly comparable market is CPUs, and those too are priced very much in line with historical levels, especially if you take broader inflation into account. Intel's Core i5-12400 is probably all the CPU most of us need, and it's yours for $185. Even the Intel gamer's choice, the 12600K, is only $250. That is far from unreasonable or out of line with historical norms.

HOW AND WHY

The upshot is that you can piece together a very well-specified PC for not a lot of money, with one obvious exception: that darn graphics card. So what gives? The simple answer is that nobody knows for sure what is going to happen to graphics card prices, but it is possible to account for how we got here and also outline the most likely scenarios for where things will go in future.

The reason why GPUs are so expensive now is a combination of a perfect storm of outside influences combined with the highly specialized nature of graphics technology and its consequent domination by a single company, Nvidia. As we know all too well, the pandemic hit at exactly the same time as GPUs were being bought in massive bulk to mine cryptocurrency, mainly Ethereum. As if that wasn't enough, war arrived in Europe, disrupting supply chains.

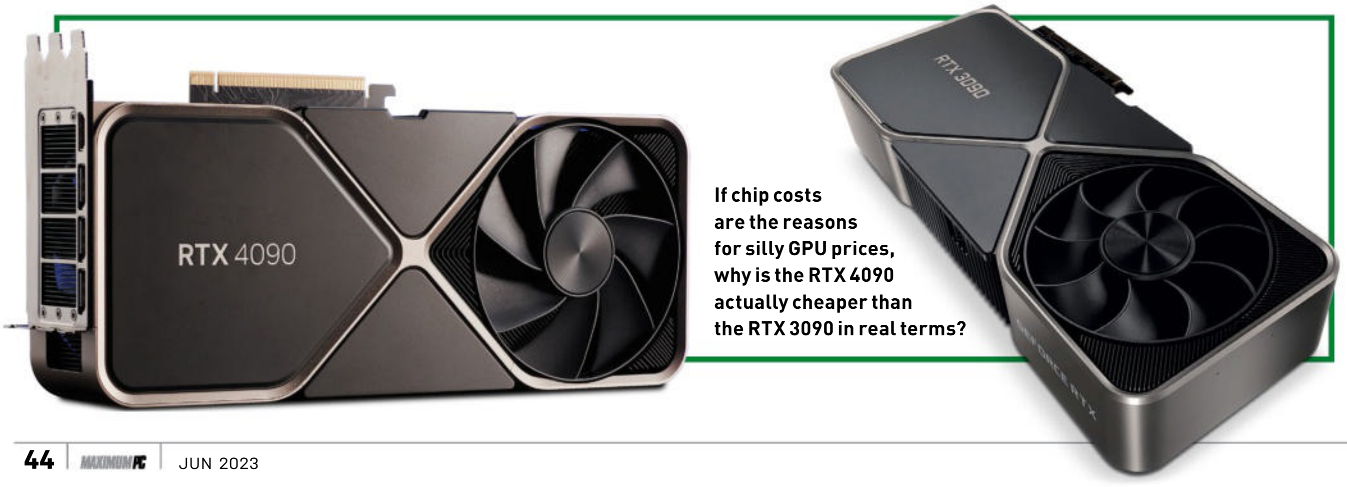


Nvidia's mean, green money-making machine: The Ada Lovelace GPU architecture.

The net result? A monumental imbalance in the classic supply and demand ratio, pushing prices up to unprecedented levels. Indeed, it's easy to forget just how crazy things got. Back in 2021, people were paying nearly $2,000 for an Nvidia RTX 3070 or $1,000 for an RTX 3060. Even the awful RTX 3050 commanded $500 for a time. AMD's boards were no better, with the RX 6700 XT hitting around $1,100, the 6800XT well over $1,500 and the 6900 XT nearly $2,000. Mercifully, things are much better now. A 6700XT can be had for about $350, while AMD's last-gen updated flagship board has recently tumbled to just over $600.

And yet many GPU prices remain far above historical levels. Nvidia's latest RTX 40 series GPUs are, inevitably, the worst offenders. The RTX 4080 is the most obvious example. It clocks in at $1,200—a massive markup over the previous-gen RTX 3080, which had an MSRP of $699, even if the 3080 sold for far more than that for most of its life cycle. Even more galling, the RTX 3080 used Nvidia's top Ampere chip, the huge and costly GA102 GPU die. But the RTX 4080 makes do with Nvidia's smaller, cheaper second-tier AD103 chip.

That's why the RTX 4090 has a much larger performance advantage over the RTX 4080 than the RTX 3090 did over the RTX 3080. The 3080 used the same silicon as the 3090, just slightly cut down, while the 4080 uses a much smaller, less powerful chip than the 4090. This means Nvidia is now charging way more



If chip costs are the reasons for silly GPU prices, why is the RTX 4090 actually cheaper than the RTX 3090 in real terms?

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Intel's Core i5-12400 is probably all the CPU most of us need and it's yours for $185. Even the Intel gamer's choice, the 12600K, is only $250.

SSDs are proof positive that chip costs have tumbled of late.

money for what is, in fact, a lower tier product in terms of the physical hardware it can offer. The same applies as you move down the RTX 40 series product stack. If anything, it gets worse.

By the time you get down to the new RTX 4070, the most recent of the Ada Lovelace generation, and currently the cheapest available at $599, Nvidia isn't even offering you more hardware for your money. Both the RTX 4070 and its RTX 3070 predecessor rock 5,888 CUDA cores. The RTX 4070 gets its performance boost mostly from clockspeed. Heck, the RTX 4070 even has a narrower 192-bit memory bus to the RTX 3070's 256-bit bus. Yuck.

Of course, Nvidia apologists will retort that the new RTX 40 series have a lot more on-die cache memory, and so don't need as much raw memory bandwidth. But those narrower buses have broader implications beyond just bandwidth, which you can read more about in the boxout on page 47. Anyway, for the RTX 4090, Nvidia saw fit to up the CUDA count to a massive 16,384 from the RTX 3090's 10,496. It also increased the 4090's clockspeed massively, and only charged an extra $100 for the 4090 over the 3090, the same premium it attaches the RTX 4070 over the RTX 3070. Something definitely doesn't make sense.

THE PRICE OF POWER

This brings us to the first major element of this story, which didn't actually happen. The most common excuse given for current graphics card pricing is increased manufacturing costs, specifically of actual GPU dies. Both AMD and Nvidia source their GPUs from Taiwanese foundry TSMC, which now dominates the market for manufacturing cutting-edge chips. The argument goes that TSMC has been ramping its prices up dramatically of late, and so all Nvidia and to a certain AMD have been doing is passing that cost on.

We can't know for sure how much TSMC has increased its prices because the amount customers pay for TSMC's exotic silicon wafers is a carefully guarded industrial secret. But if it's true that TSMC's prices are to blame, why is the RTX 4090 only $100 more than the RTX 3090? Of the new RTX 40 series, the 4090 is the only one that has maintained a similar overall chip size to its predecessor. So if the issue here is wafer costs from TSMC, the RTX 4090 should have seen the biggest price jump of all and by far. But if you take overall inflation into account since the launch of the RTX 3090, if anything it has had a slight price cut.

Similar logic applies when you look at the gaming laptop market. Nvidia recently released a range of RTX 40 mobile GPUs and laptops using them have launched at similar prices to previous-gen RTX 30 mobile portables. Are laptop GPUs somehow immune to TSMC's price increases? Hardly—they use exactly the same silicon as desktop cards.

To be clear, AMD isn't much better in all of this. It is true that AMD has effectively lowered the prices of several of its last-gen offers. The aforementioned $350 RX 6700 XT and $600 RX 6950 XT are very welcome, but AMD's latest RX 7900 series remains very expensive. You'll struggle to find an RX 7900 XTX for under $1,000. But here's the thing about AMD: it's only a bit player in the GPU market. According to long-time graphics market soothsayers JPR Research, Nvidia owns over 80 percent of the market for discrete PC graphics cards. AMD barely has more than 10 percent, with the scraps picked up by Intel's new Arc boards.

That absolutely matters, because it means that Nvidia dictates the market. Try this thought experiment: let's say AMD decided to massively undercut Nvidia with the RX 7900 series. What would actually happen? Before AMD sells any cards at all, it must decide how many GPUs to order from TSMC. As the much smaller player going into this decision, what does AMD do? Roll the dice on ordering perhaps three or four times as many GPUs as usual, and risk a glut of chips it can't sell, and a massive hole in its finances?

The good news is that you can now get a decent 1440p high-refresh Pixio PXC277 gaming monitor for under $250.

SEE PAGE 78 for the full review

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AMD's Radeon RX 7900 series are almost as bad when it comes to pricing.

Probably not, so it orders a more reasonable amount, in which case, early versions of these super-cheap (in relative terms) 7900 boards sell out and the market reacts, pushing prices up. Alternatively, AMD can do what it actually did: mirror Nvidia's pricing and sell just as many GPUs as it would have selling some of them off cheap, but at a higher price. It's a no brainer.

Nvidia's dominant position may be challenged in the long term. It's just possible that Intel may eventually have a big impact on the graphics market with its Arc GPUs. Rumor has it that its second-gen Battlemage graphics chips might match Nvidia's RTX 4080 and arrive early in 2024. That would help, for sure. But unseating Nvidia will take years, so the bulk of the explanation for how the graphics market got where it is and where it's likely to go from here must primarily account for Nvidia.

That means two major factors. The first is the influence on Nvidia itself of the boom years for GPUs that followed the crypto-craze and the pandemic. For the better part of two years, Nvidia watched its graphics cards sell for many multiples of their already high recommended prices. The GPU price spike proved that, in some situations at least, people were willing to pay far more than anyone previously thought possible for graphics cards.

If that's the first factor that likely had an impact on Nvidia's long-term thinking regarding GPU pricing, something else is almost certainly skewing the company's perception of what its products are worth. Yup, it's the AI boom. Such is the current demand for Nvidia's GPUs for use in training large language models like OpenAI's GPT systems, Nvidia can sell its enterprise-class GPUs for upwards of 10 times the amount it charges for even the $1,500 RTX 4090. Granted, Nvidia's A100 and H100 datacenter GPUs, as used for training language models, are not the same chips that go into PC graphics cards, and they do come with more memory and cost more to manufacture. But not that much more.

For example, Elon Musk reportedly just bagged 10,000 Nvidia GPUs for his TruthGPT AI initiative in a single deal that probably cost at least $100 million. It is anyone's guess whether this boom in Nvidia GPUs for AI training will last or what will happen to the industry in general. Will competitors like Tenstorrent or Microsoft's in-house efforts to create their own AI chips and pull the rug from under Nvidia's currently dominant market position?

Maybe, but for now the impact of the AI boom can only increase Nvidia's estimation of the value of its GPUs. AI GPU sales surely also make GPUs for gaming look less important. More broadly, Nvidia's revenues from gaming GPUs are now about half of those it generates from those data center chips. Nvidia is no longer predominantly a gaming graphics company.

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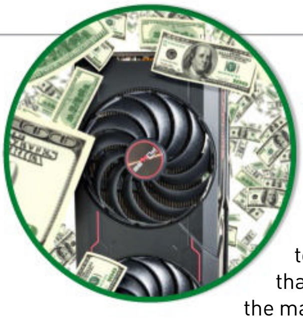


THE FUTURE

PC graphics therefore finds itself in the strange position of being dominated by a company for which the PC and gaming are becoming less important. But in the short to medium term, there's also no avoiding that it's Nvidia calling the shots. It dominates the market. So how does this all play out?

Firstly, in the long term, it isn't viable for gaming graphics to be so costly. PC gaming, by definition, has to be a mainstream pursuit to make sense. What game developer is going to invest millions in a new PC title if the potential market is a small niche of wealthy PC owners who can afford a megabucks GPU? Big games need markets measured in millions of gamers to make sense, so either graphics cards get cheaper or PC gaming dies.

Mercifully, there are signs that the tide is turning. We're not talking about the end of huge markups over recommended retail pricing, but early indications are that even Nvidia can only prop up the painfully high recommended pricing itself for so long. There are widespread reports from retailers across the globe that both the Nvidia RTX 4070 Ti and RTX 4070 have been slow sellers.

It's also obvious that both cards have maintained high levels of availability. Popular GPUs have a tendency to sell out, especially shortly after initial launch. But as we write these words, there's plenty of availability of the RTX 4070 a few weeks after launch. Even more significant, a few RTX 4070s have already been offered slightly below the recommended $599 retail pricing.

Earlier in the RTX 40 series launch cycle, there was the aborted RTX 4080 12GB debacle, a card that was supposed to launch at $999, but was "unlaunched" in response to a negative response to its mere announcement, let alone a review.

Nvidia withdrew the card, admitting that the RTX 4080 12GB wasn't "named right." What they failed to explicitly acknowledge is that when it relaunched the 4080 12GB with a new name, but the same hardware specifications, in the RTX 4070 Ti, it also cut the price to $799. But even at that lower price, what was once the $999 4080 12GB doesn't seem to have been a hit with gamers.

Nvidia has been under relentless pressure since it began rolling out RTX 40 cards, then, and there is no doubt that it's had an impact. That pressure will only increase if AMD can deliver some competitive mid-range GPUs with its new RDNA 3 architecture. If Intel can do likewise with its upcoming second-gen Arc graphics, then the market will be more competitive still.

There are no guarantees, but there is cause for cautious optimism. GPU prices continue to fall—whether they get back to where they were before the crypto-craze, the pandemic, and Nvidia developed a taste for megabucks graphics boards, that's a tall order, but definitely not impossible. Here's hoping.

Mercifully, some of AMD's older GPUs, like the 6950 XT, have seen big price drops.

THANKS FOR THE MEMORY

WHY NVIDIA'S STINGY MEMORY BUSES AREN'T JUST BAD FOR BANDWIDTH

Just enough. That's been Nvidia's approach to graphics memory for a while now. Previous-gen Ampere cards are a good example. The RTX 3080 got 10GB of VRAM. That was just enough at the end of 2020, but looks increasingly marginal today.

Ditto the 8GB bequeathed to the RTX 3070 and RTX 3070 Ti models. It was just enough two years ago—not so much today. The problem is the number of games that use more than 8GB of graphics memory even at 1080p, let alone higher resolutions, is definitely on the up. Notable holders of the dubious honor of breaching 8GB at 1080p include *The Last of Us*, *Hogwarts Legacy*, *Resident Evil 4*, *A Plague Tale: Requiem*, *The Callisto Protocol*, and several more.

Some would argue that those games are just poorly optimized, and that there's no need for any of them to breach 8GB of VRAM at 1080p. But that's by the by. The fact is they do, and the consequence for any graphics card with just 8GB of VRAM is catastrophic in terms of performance and sometimes image quality, the latter because some games simply don't bother to load certain textures when the GPU runs out of memory. Ugly.

Ironically, it's often enabling ray tracing that pushes the latest games well over 8GB. The result can be the counter-intuitive situation where enabling ray tracing makes a given Nvidia card slower than the AMD competition, which certainly is not normally the case. Whatever the case, Nvidia's problem going forward is that it has been aggressively lowering the specs for its new RTX 40 series boards. That includes using smaller, cheaper chips with narrower memory buses, tier for tier, so the new RTX 4070 and RTX 4070 Ti get 192-bit buses, down from 256-bit on the RTX 3070 and 3070 Ti. The upcoming RTX 4060 and RTX 4060 Ti are expected to run 128-bit buses.

The usual complaint is that there is reduced memory bandwidth, and that will be the case, albeit offset by increased on-die cache memory. But the real problem with those narrower buses are the limitations it puts on VRAM allocation. Graphics memory chips are only available in certain densities and bit widths. Long story short, for a given GPU memory bus width, you only have certain options regarding overall VRAM amounts.

So for a 256-bit bus card, the realistic options are 8GB and 16GB, and for a 192-bit card it's 6GB or 12GB. For a 128-bit board, Nvidia is effectively going to be limited to 8GB for the RTX 4060 and 4060 Ti. It couldn't do 12GB even if it wanted to, and it won't matter how much on-die cache the RTX 4060 and 4060 Ti have if they run out of VRAM playing the latest games at 1080p. Surely 1080p is not too much to ask of a graphics card that in the case of RTX 4060 Ti is probably going to cost upwards of $400. Has Nvidia gone too far this time in trying to cut costs? Watch this space. There's a real risk of some very ugly benchmark results when it launches its next RTX 40 series cards.

SteelSeries Arena 9

ARE HEADPHONES literally doing your head in? Are they cramping your style by causing a permanent indentation in your hair? Maybe you just need to keep an ear out for someone in your household and your noise-canceling headphones are getting in the way of that? Speakers might be the solution.

More likely, you want to have both a good set of headphones and a pair of speakers for your setup, and boy do the SteelSeries Arena 9 speakers fit the role of the latter. If kicking back and playing a casual or story-driven game is your thing then you'll be more than happy with the Arena 9 setup. Being the most premium model SteelSeries offers, sitting above the 3&7 variants, it delivers a true 5.1 surround sound experience. The package includes a 6.5" down-firing subwoofer, one center speaker (with two woofers and one tweeter), two front speakers (left and right), and two rear wireless speakers (left and right).

The sound quality surrounds you with velvety rich highs and sound you can rally feel. These push out a punchy yet detailed soundscape, thanks to the tweeters and the subwoofer. It's best to keep the latter on the floor—all of the speakers and the controller connect to the subwoofer so despite the long cables, it's best to keep it close to your PC. The two wireless speakers connect together and need an outlet to power them, so bear that in mind. To amp up your setup, you can't go wrong with the Arena 9 speakers from SteelSeries. –SAM LEWIS

steelseries

1 STRONG COMPATIBILITY

Not only can you use this speaker setup with your PC via USB, you can connect it to your PlayStation or Mac. With a 3.5mm auxiliary option available too, it can be used with most devices. To get the full 5.1 surround sound though, you'll have to use a single USB to PC connection.

2 A SOFTWARE MUST

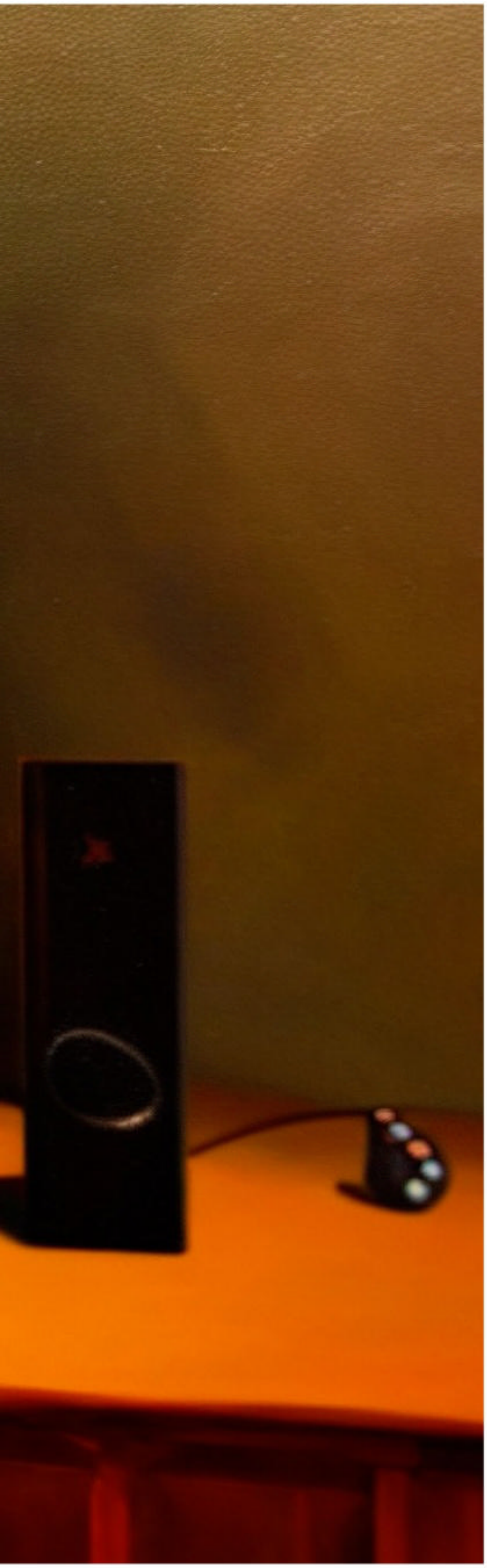
Download the SteelSeries Engine application to take full advantage of the Arena 9 Speakers. It's important to tweak the equalizer to get the best sound for you in your home. It will also provide you with any firmware updates to keep your speakers running smoothly.

3 RGB

Of course, it wouldn't be a gaming-related PC product without a splash of color now, would it? This is adjustable within the SteelSeries Engine application or on the included control pod. If you want reactive lighting then that's achievable here, which will dance to the audio or even on-screen action.

4 CONTROL POD

Don't want to head into any settings and prefer adapting your sound on the fly? SteelSeries thought of this, and the included control pod offers volume, equalizer, lighting, and input settings for your speakers via a dial and an OLED screen. Not only this, it also has a 3.5mm input on it for a wired headset.



THIS PC DOES NOT EXIST

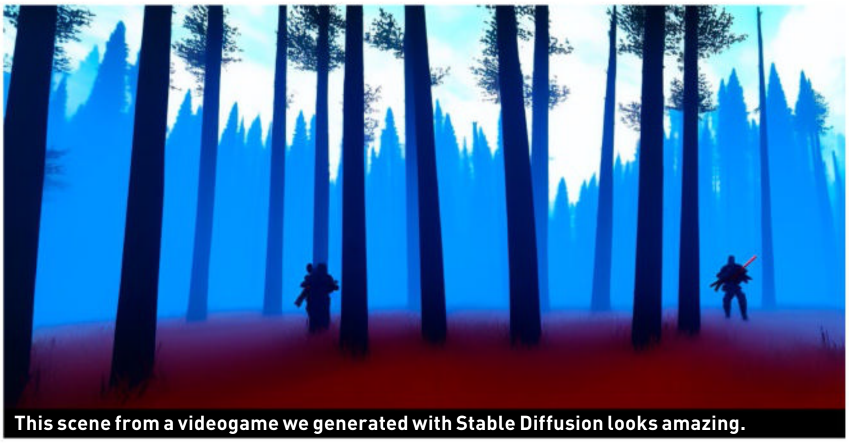
AI that creates text and images is a developing field that's getting a lot of news coverage. *Ian Evenden* explains what's going on

The question of artificial intelligence has been a hard one to get away from, with ChatGPT hitting the headlines as both an amazing scientific advance and the harbinger of the end of civilization. Which is it? Well, as with many tech stories in the papers, it's a bit more complicated than a simple binary choice.

What has been released to the public are still a long way from the AIs we're used to seeing in science fiction. They're generally capable of doing one thing, whether that's holding a conversation or creating images of the Pope in a fashionable white coat (or the image that opens this feature) that are photoreal enough to fool the casual observer. We've yet to see one that can do both, though ChatGPT is as capable at writing in programming languages such as Python as it is in English or Spanish.

This is also a developing field, where advances come quickly and suddenly. The difference between ChatGPT 4 has been claimed to be ten times as complex as ChatGPT 3.5, despite there being only three months between their releases.

So what are these AIs? How do they work? Are they going to destroy the world? And can I run one on my PC?



This scene from a videogame we generated with Stable Diffusion looks amazing.

Do you remember Clippy? The Office Assistant from Microsoft Office 97 through 2003 was actually called Clippit, but the misnomer stuck, and presented as an anthropomorphized paperclip (though other skins were available). It used algorithms to analyse what you were writing in Word, for example, and popped up with helpful advice, based on Bayesian probability, about writing a letter or a report for the 30 nanoseconds before you turned it off.

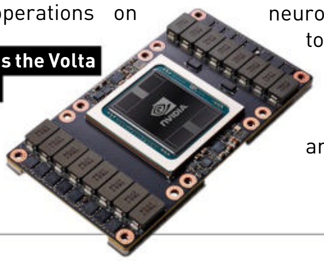
Nobody at the time called Clippy an AI, but at heart what we're seeing in the AIs of today is a development of the same thing. They take a text prompt provided by the user, and produce output based on probability and the huge amount of training data they've been exposed to. This training regime is reflected in the name of ChatGPT—the GPT part standing for generative pre-trained transformer.

These in turn are part of a family of systems called LLMs, or large language models. These are neural networks, collections of computing nodes loosely based on the arrangement of neurons in a biological brain. The LLM is 'large' because it contains potentially billions of parameters. A parameter is a matrix—an array of numbers arranged in rows and columns like a table—that the LLM uses to define a word and its connections to other words. The greater the number of parameters, the better an LLM's understanding of a word's meaning and the way it's used, and the wider the range of tasks it appears to be able to complete.

So to make a better AI using the LLM method, you simply make it bigger. LLMs use self-supervised machine learning to sift through the training data they're given and compute the matrices that will form the model. This takes time, and is improved by adding more computational capacity, which is why if you use ChatGPT, Stable Diffusion, Adobe Firefly, or any of the prompt-based AIs currently available, you interact with them through a web browser (or Discord in the case of Midjourney), with the neural network executing in a data center somewhere.

There's one part of a computer we're all familiar with that's used in these data centers, and that's the GPU. The graphics chips we use for gaming and rendering are particularly well-suited for generative AI, because they are optimized for parallel processing, which allows them to perform complex mathematical operations on large datasets quickly and efficiently, as well as carrying out many matrix multiplications and other mathematical operations simultaneously.

Compared to CPUs, which are designed for sequential processing, GPUs have thousands of cores that can handle multiple computations at the same time. This makes them faster than CPUs when it comes to performing the operations required for training generative AI. GPUs also have high memory bandwidth, which lets them move data quickly between the processor and memory.



Nvidia's Tesla V100 card uses the Volta architecture and, according to Nvidia, offers the AI performance of 100 CPUs.

© NVIDIA

GENERATIVE LANGUAGE MODELS

That's the 'pre-trained' part of GPT's name, but what about 'generative'? This refers to the ability of the model to create new, coherent text that is similar in style and content to the text it has been trained on. A generative language model, such as GPT-3, uses statistical models and machine learning algorithms to learn the patterns and structures of language from large datasets, and then uses that knowledge to generate new text. By essentially placing the most likely words in a sentence that follows the rules of the prompt it's been given, it's a bit like the predictive text input on your phone, only dialled up to many times the size.

Generative language models can be used for a variety of natural language processing tasks, such as language translation, text summarization, and text completion. They can also be used to generate creative or imaginative text that is often indistinguishable from text written by humans.

The third part, 'transformer', refers to the way it processes input data, using neuro-linguistic processing to decode the prompt and apply it to the training data it has absorbed.

The current crop of AIs are essentially algorithms, dependent on their training data for the responses they give to prompts. ChatGPT 3.5, at the time of writing the most advanced version it's possible to access for free, ceased its training in 2021, so if you ask it about events in 2022, you get a response like this:

"I'm sorry, but as an AI language model, I do not have access to information from the future. My training data only goes up until 2021, so I am not able to provide you with any reliable information about the year 2022 or any other future events.

"Predicting the future is also very challenging, and there are many factors that can influence what happens in a given year, including political, economic, social, and environmental factors. It is important to approach predictions about the future with caution and recognize that they are often based on incomplete information and subject to change."

That brings up one of the most contentious things about this generation of AIs. Because they're not thinking for themselves, but instead applying mathematical operations to crawls of the internet, they only know what they've been told, and can't even do something as cursory as a Google search to improve their knowledge. Many in the artistic community are up in arms about AI image generation, which has ingested all manner of photos, paintings, and other art posted online, and which can create a new image in the style of a particular artist with just a text prompt and a few seconds' wait.

The argument that AIs from utopian science fiction were supposed to take over the drudgery and repetitive admin tasks to free up humans' time for artistic endeavours, but instead we seem to be outsourcing art to AI so we can spend our time doing boring things instead, is a pervasive one among those who see the rise of the AIs as a negative thing.

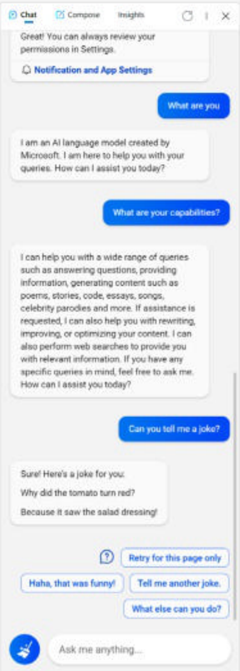
Another problem is that while their training data may be set in stone, this

The PC cases the AI produces are an absolute mess up close, but there's enough there to identify what they are straight away.

doesn't stop them from making things up. Known as 'hallucination', you can get a plausible response from an AI chatbot that has no bearing in reality. The UK's *Guardian* newspaper ran an article at the beginning of April in which its head of editorial innovation, Chris Moran, wrote about emails the paper had received asking it about articles that didn't exist, but which had been suggested to researchers using ChatGPT instead of Google.

The same problem can be seen in AI-generated images, in which the number of teeth or fingers present on a person far exceeds the usual human standards. Updates to the models used are cutting down on the problem, though image generators still can't get hands quite right all the time, and when we asked ChatGPT for the lyrics to the traditional folk song 'We Love Maximum PC', it told us it didn't exist rather than making something up. If you're thinking of writing in to our letters page with your own, a good rhyme for Maximum is taraxacum, the plant family that includes dandelions.

Writing in the *New York Times*, linguist Noam Chomsky addressed the problem, concluding that AI chatbots differ profoundly from how humans reason and use language, as well as from the digital assistants—Alexa and Siri—that we've become used to, which are kept under strict rules to ensure that the information they give out is as correct as possible. The human mind, in his view, is not a statistical engine for pattern matching, but a surprisingly efficient system that operates with small amounts of information, seeking to create explanations. Machine learning requires adaptation, and is focused on description and prediction, lacking the ability to provide causal explanations and make counterfactual conjectures. Machine learning programs have limitations and are incapable of distinguishing the possible from the impossible, explaining the hallucinations.



Great! You can always review your permissions in Settings.

What are you

I am an AI language model created by Microsoft. I am here to help you with your queries. How can I assist you today?

What are your capabilities?

I can help you with a wide range of queries such as answering questions, providing information, generating content such as poems, stories, code, essays, songs, celebrity parodies and more. If assistance is requested, I can also help you with rewriting, improving, or optimizing your content. I can also perform web searches to provide you with relevant information. If you have any specific queries in mind, feel free to ask me. How can I assist you today?

Can you tell me a joke?

Sure! Here's a joke for you:

Why did the tomato turn red?

Because it saw the salad dressing!

The new Bing Chat panel in the Edge browser uses ChatGPT to provide natural language answers to questions.

© BING

THE DATA FACTOR

There's a further issue: the quality of the training data. In 2016, before LLMs were mainstream tech, Microsoft experimented with a Twitter bot called Tay, designed to mimic the language patterns of a 19-year-old woman and learn from its conversations. It managed 96,000 tweets in response to other Twitter users in the first 16 hours after its initial release, after which it was suspended. The reason was the way it learned from its conversations—users subjected it to controversial and often plain unacceptable language and opinions, which it integrated into its replies, going as far as to claim the Holocaust was 'made up'.

Microsoft adjusted Tay, but accidentally re-released it into the wild during testing, during which time it made the most of its freedom by tweeting about drugs before getting stuck in a loop and being shut down again. At the time of writing, the @tayandYou account still exists on the site, but is protected.

What of the future? Nvidia is a big noise in AI. Many of the data centers that run the LLMs we're beginning to interact with are using Nvidia's GPUs, and anyone with a graphics card that supports DLSS is taking advantage of it to generate pixels, or even frames in the case of DLSS 3.

In fact, Nvidia sees AI as having a large role in the future of game graphics. CEO Jensen Huang is often quoted as having said, "Every single pixel will be generated soon. Not rendered: generated", though we were unable to track down the source of this quotation beyond Twitter threads and Substack posts asserting it to be true. It is, however, an interesting idea, that games could present you with photoreal views of places and people that don't exist (perhaps even with the correct number of fingers) that are refreshed 60 times a second by a GPU in your PC acting as an AI accelerator rather than as a traditional texturing and lighting platform.

In this imagined future, game developers become masters of manipulating the text prompts, which act like the seeds already used to create procedurally generated levels. Perhaps we'll even classify games by the number of words used as their prompt, with reviewers amazed at what can be achieved with a mere 50,000 or so.

Clippy may be dead, though his image lives on as the paperclip emoji in Windows 11, but the age of AI is only just starting. Prof Stuart Russell, founder of the Center for Human-Compatible Artificial Intelligence at the University of California, Berkeley, has said experts are "increasingly spooked" by the speed of progress in the AI field and its burgeoning effect on society, and that machines more intelligent than humans will be created in the 21st century. 2099 is a long way away, but in today's many-fingered portraits and carefully moderated chatbots, we can see the stirrings of something that could change the world.

Run Stable Diffusion on your own PC

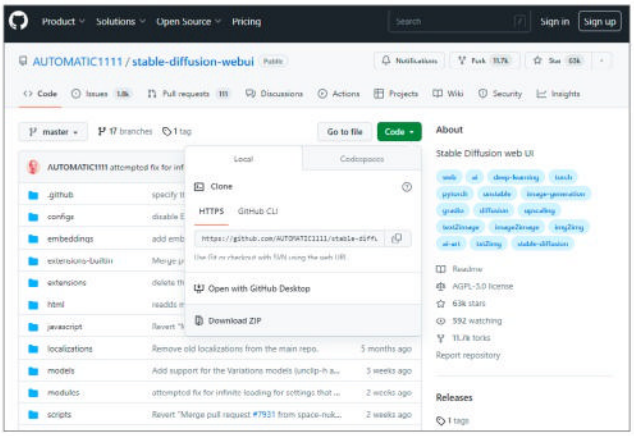
YOU'LL NEED THIS

A GPU
and plenty of time to spend downloading

WHILE MOST OF THE TEXT- AND IMAGE-GENERATING AI MODELS we've discussed here run in massive throbbing data centers on racks of GPUs—indeed, Elon Musk purchased 10,000 Nvidia cards in March for an unannounced AI project within Twitter—there is one that can be run on your home PC.

Stable Diffusion is a deep learning text-to-image service that was released in 2022. It uses a diffusion model rather than a large language model, but the concept is broadly similar in that it's probability based and is trained from images harvested from the wider internet, plus words associated with them, as well as versions of the same images that have been blurred. With this knowledge, Stable Diffusion is able to begin with a frame full of random image noise, and works to de-blur it to 'reveal' the image. The final result is based on the model's training and the prompt it's provided with.

If you go to stablediffusionweb.com, you'll be able to use Stable Diffusion to create images, but it's also possible to run it on your own PC as long as your graphics card has 6GB or more VRAM. It doesn't matter if the card is from AMD or Nvidia, as it doesn't use any technology that's specific to a manufacturer. It's the RAM allocation that counts, though it also helps if your card is a newer one. You'll need to download a lot of data to make this work, but once you've got it, you'll have your own image generation service at your fingertips. There's no copyright on AI-generated images, and those created by Stable Diffusion are fully public domain, so you'll be able to use them in social media posts, college assignments, hilarious pranks, and even more.


Product
Solutions
Open Source
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Sign in
Sign up
AUTOMATIC1111 / stable-diffusion-webui
Code
Issues
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Discussions
Actions
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Code
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Clone
HTTPS
GitHub CLI
https://github.com/AUTOMATIC1111/stable-diff
Open with GitHub Desktop
Download ZIP
About
Stable Diffusion web UI
Readme
AGPL-3.0 license
63k stars
592 watching
Report repository
Releases
1 tags
.github
configs
embeddings
extensions-builtin
extensions
html
javascript
localizations
models
modules
scripts

1 DOWNLOAD AND DOWNLOAD SOME MORE

We're going to show you how to install Stable Diffusion with a GUI on Windows, as we suspect that no one really likes messing around with command prompts. You'll need to have Python (the programming language) and Git (the version control system) installed first, which are easily acquired from python.org/downloads and git-scm.com/download/win respectively.

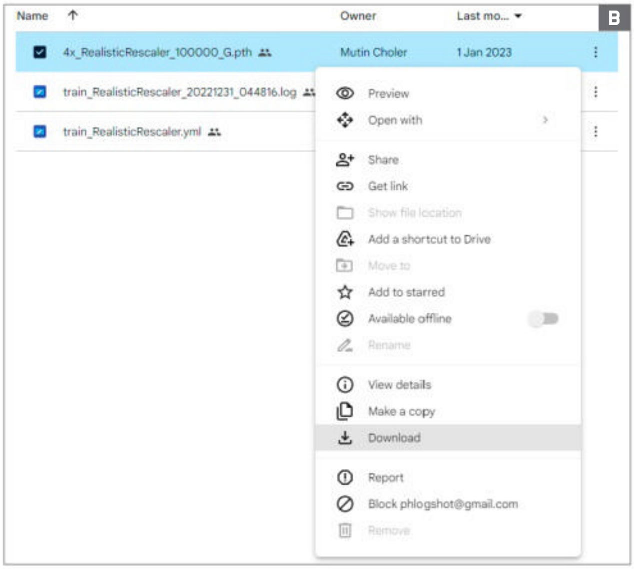
» Once these are installed, you'll need the Stable Diffusion GUI GitHub repo, which is at https://github.com/AUTOMATIC1111/stable-diffusion-webui. Click the green Code button and choose Download Zip [**Image A**]. Unzip the file and save it wherever you want, but make sure you keep a note of the folder location, as it will become the working folder for the installation.

» If you don't want to (or can't) download Python and Git, there's a version with everything included available at https://github.com/AUTOMATIC1111/stable-diffusion-webui/releases/tag/v1.0.0-pre, but it works with Nvidia GPUs only.

» Next, you're going to need some checkpoints. These are a dump of an AI model's internal state at a specific point, and are a great alternative to setting up and training your own. You can get them from the machine learning community Huggingface, and specifically you want sd-v1-4.ckpt from https://huggingface.co/CompVis/stable-diffusion-v-1-4-original. It's over 4GB, but once it's down, put it in the "stable-diffusion-webui-master\models\Stable-diffusion" folder and rename it to model.ckpt.

2 KEEP ON DOWNLOADING

There's more. You'll also need as many ESRGAN (Enhanced Super-Resolution Generative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Available offline
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View details
Make a copy
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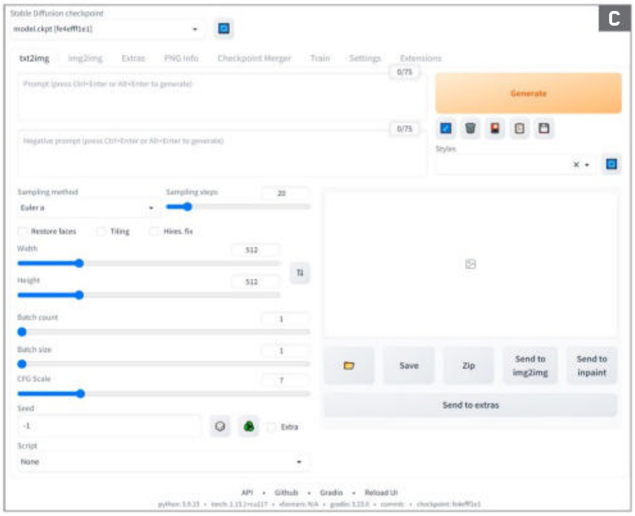
Report
Block phlogshot@gmail.com
Remove

© STABLE DIFFUSION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Negative prompt (press Ctrl+Enter or Alt+Enter to generate)
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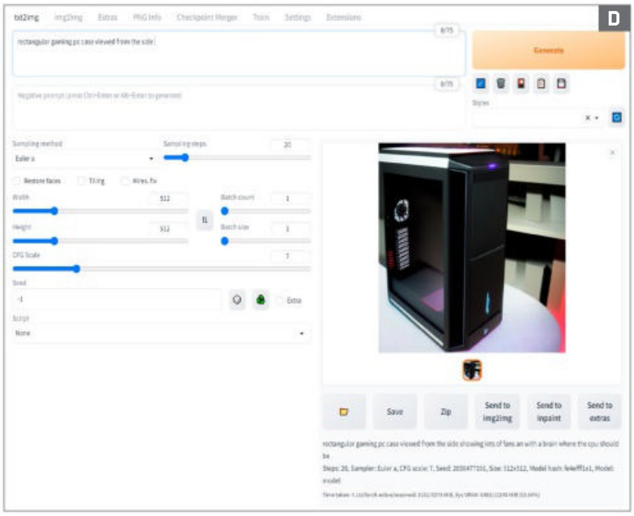
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None
Save
Zip
Send to img2img
Send to inpaint
Send to extras

rectangular gaming pc case viewed from the side

Adversarial Networks) checkpoints as you like from https://upscale.wiki/wiki/Model_Database. There are lots of these, so scroll through the list and see what catches your eye. We went for Realistic Rescaler in the Realistic Photos section, which was about 128MB, but if your artistic tastes lean toward drawings or manga, pixel art, or faces, you'll find something to suit you on the list. Realistic Rescaler is also on the WTFPL license, which is public domain-like. Clicking the link in the wiki takes you to Google Drive [**Image B**], from where you can download the .pth file. Others may come in a .zip that will need extracting. Put the file in the "models/ESRGAN" folder, which you may need to make yourself.

3 BATCH FILE

Now, find the file webui-user.bat in the "stable-diffusion-webui-master" folder, and double-click it to run it. There's more downloading and installing to do, but the file does it for you. However, it may take some time. You'll get a message in the console that says "Running on local URL: http://127.0.0.1:7860" if it's successful. Don't close this window until you're finished, as it's where the model actually runs, and you'll be able to see progress bars and error messages when you hit the Generate button in the web UI.

4 USE IT!

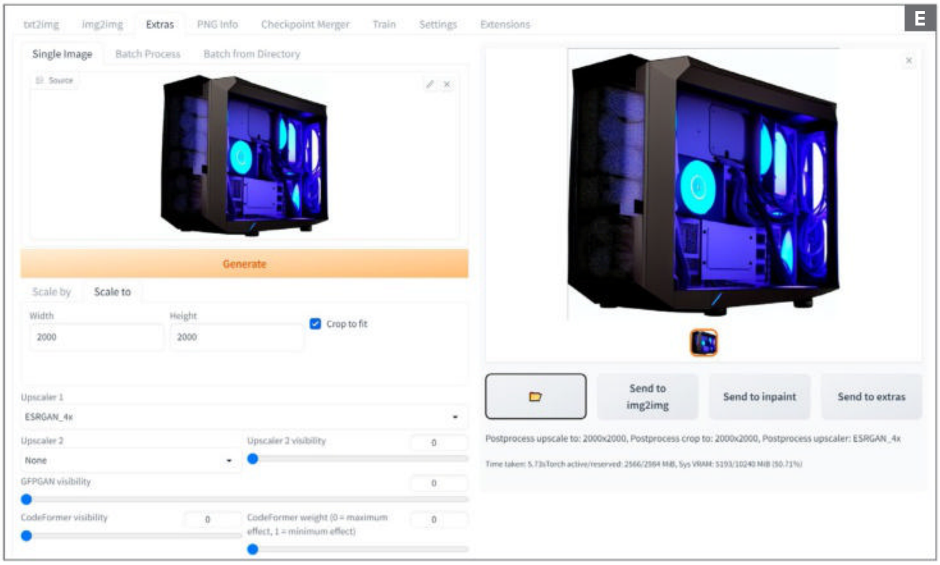
To use your new Stable Diffusion installation, open a new browser tab and type "127.0.0.1:7860" into the address bar. Something that looks very much like [**Image C**] should appear. The interface is divided into tabs, and the main one for producing images from text prompts is the one labelled txt2img. This is where you type your text prompts, and see the generated images. [**Image D**]

5 CHANGING THE SIZE

By default, Stable Diffusion creates images that are 512px square, but there are two ways to change this. The first is by increasing the dimensions in the Width and Height sections of the txt2img tab (though this can cause you to run out of memory, we found that keeping dimensions around 1280x720px was enough for a 10GB RTX 3080, producing image in about a minute with 100 sampling steps), while the other involves the Realistic Rescaler we installed earlier. To use this, click the Send to Extras button below the image once you've generated it, then move across to the Extras tab, choose Scale To, input new, larger pixel dimensions, make sure the ERSGAN you want to use is selected, and click Generate [**Image E**] . Images are saved automatically in the \stable diffusion\stable-diffusion-webui-master\outputs\extras-images folder, though you can change this in the settings.

6 GO WILD

As you'd expect from the world's greatest PC hardware magazine, we spent our time with Stable Diffusion creating PC cases and videogames, but you can go anywhere your mind takes you. The CFG slider on the txt2img tab sets how closely the AI sticks to your prompt, so lower it to get more imaginative results. ⏻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☑ Crop to fit
Upscaler 1
ESRGAN_4x
Upscaler 2
None
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GFPGAN visibility
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CodeFormer visibility
0
CodeFormer weight (0 = maximum effect, 1 = minimum effect)
0
Send to img2img
Send to inpaint
Send to extras

Postprocess upscale to: 2000x2000, Postprocess crop to: 2000x2000, Postprocess upscaler: ESRGAN_4x

Time taken: 5.73sTorch active/reserved: 2566/2984 MiB, Sys VRAM: 5193/10240 MiB (50.71%)

BLUETOOTH

THE TOOTH SHALL SET YOU FREE

Darien Graham-Smith explores the Bluetooth standard, and finds out how to get the best audio quality from your wireless headphones

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© DAVID HANCOCK/ALAMY STOCK PHOTO

BLUETOOTH has become so commonplace that you probably used it today without even thinking, but it's a technology that is worthy of deeper consideration. For a start, it's unique. Similar to Wi-Fi in some ways, but with a different topology and a shorter range, intended for "personal-area networking" (PAN), rather than a whole-home LAN.

In case you'd wondered, "Bluetooth" was originally the colorful nickname of Harald Gormsson, king of Denmark in the 10th century. The connection between short-range networking and the Danish monarchy isn't obvious, but the ostensible explanation is that Gormsson united the tribes of Denmark into a single kingdom, and Bluetooth similarly brings a whole range of networking protocols into one standard.

If that sounds like a stretch, it may also have helped that Gormsson's initials were written as a neat rune that looks like an angular B with a pair of antennae sticking out the side—which became the official Bluetooth logo.

WHO INVENTED BLUETOOTH?

Bluetooth was dreamt up in 1989 at Ericsson Mobile in Sweden, then one of the biggest names in the fast-growing mobile phone industry. CTO Nils Rydbeck had a vision of people talking on hands-free wireless headsets, without having to take their phones out of their pockets, and he tasked company engineers with making it a reality.

By 1997, Ericsson had a simple short-range radio system working in its labs, and with dial-up internet access growing in popularity, IBM happened to be seeking a way to use mobile phones as portable modems for its ThinkPad laptops. IBM and Ericsson agreed to build it together on the nascent Bluetooth platform, and opened up the standard to encourage other companies to get involved in its development. Intel, Nokia, and Toshiba came on board, with the five companies forming the Bluetooth Special Interest Group (SIG).

Since then, Apple and Microsoft have also joined as major contributors, while IBM—having departed the laptop business—has been replaced by Lenovo. More than 35,000 technology companies around the world now participate in the development and certification of new Bluetooth standards.

WHAT'S THE DIFFERENCE BETWEEN BLUETOOTH AND WI-FI?

Bluetooth and Wi-Fi both use radio signals to exchange data packets between computers and other devices. However, while Wi-Fi networks are normally managed by a central router, Bluetooth devices pair directly to a single host computer, phone, or tablet. This means Bluetooth networks are generally a lot smaller—while a Wi-Fi router can happily handle more than 100 connected devices, a Bluetooth host will normally support between seven and nine connections.

Another difference is how the two technologies use the radio spectrum. In the beginning, both Bluetooth and Wi-Fi operated in the 2.4GHz frequency range. Since then, Wi-Fi has added dozens of channels in the 5GHz and 6GHz ranges, while Bluetooth continues to operate on a tight band of frequencies between 2,402MHz and 2,480MHz.

This isn't a big problem for Bluetooth. One advantage of using higher frequencies for Wi-Fi is that they're less affected by interference, but Bluetooth minimizes that issue via a technique called adaptive frequency hopping. This divides the operating spectrum into 79 narrow 1MHz channels (or 40 2MHz channels with the newer LE standard), automatically switching to a new channel when potential interference is detected.

Wi-Fi can't do this anything like as effectively, because its channels are much wider—they can range between 20MHz and 160MHz—and there's limited space in the available spectrum to switch to. However, those fatter channels provide much more bandwidth: Wi-Fi 6 can theoretically transfer data at up to 4.8Gbits/sec over a 160MHz channel, while a 1MHz Bluetooth channel can't go over 3Mbits/sec. So while Bluetooth can provide a more consistent connection than Wi-Fi, it's overall a more limited, smaller, and slower technology.

WHAT'S BLUETOOTH GOOD FOR?

Although Bluetooth isn't as powerful as Wi-Fi, it has advantages. One is that it consumes less power: most Bluetooth devices have a maximum transmission power of 2.5mW—a mere fraction of the

Right **Bluetooth was developed in the early days of the mobile industry.**

Bluetooth 6 may support real-time VR or AR experiences.

100mW that's standard for Wi-Fi devices. This means that compact Bluetooth accessories such as headphones and watches can run for a day or more off a tiny rechargeable battery. Peripherals such as computer keyboards and mice can use mid-sized batteries, and work for months between charges.

Another advantage of Bluetooth is that it makes connecting very simple: devices can be paired by just pressing a button, and optionally entering a PIN. Admittedly, that's the same process as using WPS to connect to a Wi-Fi network, but there's more. When a Bluetooth device connects to a host, it advertises its profile capabilities, telling the host what it can do. The host can then enable those capabilities without further configuration.

For example, if you connect a Bluetooth mouse to a laptop, the HID (human interface device) profile will instantly let you use it to control the mouse pointer. Hook up a loudspeaker, and the A2DP (Advanced Audio Distribution) profile lets you start streaming audio. Connect a headset to a phone, and you can use it for calls, along with basic controls such as adjusting the volume and ending conversations. There are more than 30 defined Bluetooth profiles covering a range of services, from exchanging data files to working with images, printing documents, and sending faxes. Perhaps the Gormsson allusion isn't such a stretch.

Bluetooth also has certain security advantages over Wi-Fi. For one, the lower transmission power makes it harder to spy on Bluetooth transmissions. Also, new connections can only be made when the devices have been manually put in pairing mode, so an unauthorized person can't join a Bluetooth network unless someone lets them in, or they get physical access to approve the connection.

THE LATEST STANDARDS—AND WHAT'S COMING NEXT

All Bluetooth hosts and devices are backward-compatible with older standards, and anything you buy today that carries the Bluetooth logo is required to support at least version 4.2. This means you can normally expect Bluetooth devices to work together seamlessly, without worrying about version numbers.

There are, however, some specific capabilities to look out for. In particular, Bluetooth 5.2 supports the new low-energy audio standard (see below). As well as offering improved battery life and sound quality, LE Audio allows an unlimited number of listening devices to connect to one audio source by scanning a QR code or tapping an NFC tag. This is a major new feature, and the SIG has given the technology a brand name—Auracast. A marketing push is planned for later in the year, with a focus on televisions, particularly ones in public places, and assistive technologies such as hearing aids and audio description services.

If that interests you, it's worth checking the specification before you buy your next Bluetooth device. Bluetooth 5.2 isn't yet universal, but it's becoming widespread, and a few devices—including the Apple iPhone 14 and the latest Apple Watch models—have already moved to the very latest Bluetooth 5.3 standard.

As for the future, no concrete information has been released about the capabilities of Bluetooth 6. However, in November 2022, the Bluetooth SIG revealed that it was working to extend BLE into the 6GHz frequency range. That suggests an intention to deliver increased bandwidth and lower signal latency, potentially enabling Bluetooth to support rich, real-time VR or AR experiences.

Right **Ericsson Mobile was the impetus behind the Bluetooth standard.**

©ROB WILKINSON / ALAMY STOCK PHOTO, GORODENKOFF/ISTOCK / GETTY IMAGES PLUS

Bluetooth versions

2001 BLUETOOTH 1

The original Bluetooth specification provided basic connectivity for voice and data connections. Bluetooth 1.1 followed shortly afterwards, containing mostly bug fixes; in 2003, Bluetooth 1.2 added the adaptive frequency-hopping technology that helps Bluetooth avoid the worst effects of interference.

2005 BLUETOOTH 2

The second major release of Bluetooth introduced the "enhanced data rate" mode (EDR), raising maximum connection speeds from 721Kbits/sec to 2.1Mbits/sec. Soon afterward, Bluetooth 2.1 added easy pairing, permitting devices such as headphones to pair with no user confirmation, or by simply tapping to confirm the connection.

2009 BLUETOOTH 3

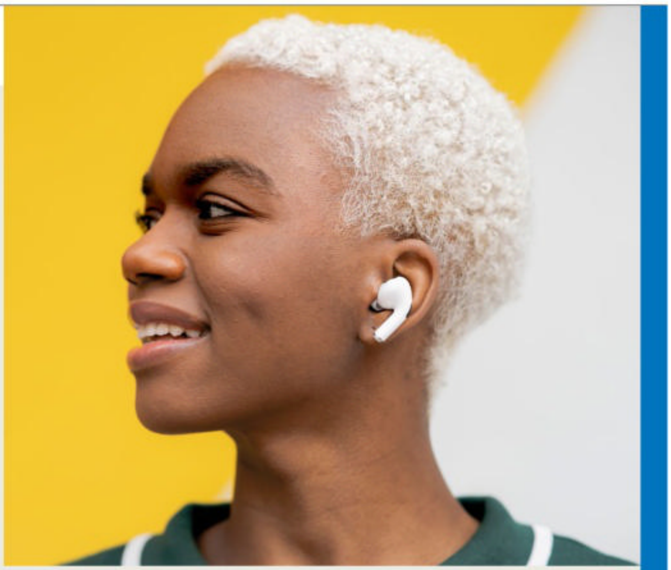
Bluetooth 3 massively increased the performance potential of Bluetooth with a new high-speed (HS) data-transfer mode supporting speeds of up to 24Mbits/sec. This was a bit of a cheat, though, as the high-speed channel used a separate Wi-Fi-type radio, increasing the size, cost, and power consumption of the whole module. For these reasons HS was defined as an optional extra capability, and was never widely implemented—although it's still officially supported today, under the "Bluetooth+HS" brand.

2010 BLUETOOTH 4

The fourth-generation Bluetooth standard brought the biggest update the technology has seen: a new "low-energy" mode known as Bluetooth LE, or just BLE. When used with compatible devices, this slashed power consumption in exchange for reduced bandwidth—as low as 125Kbits/sec for devices wanting to achieve the best battery life.

Three years later, Bluetooth 4.1 increased efficiency further by allowing devices to manage their own power states, and enabling them to talk directly to one another, rather than having to communicate via the host. Bluetooth 4.2 made it possible to use Bluetooth over IPv6, rather than relying on native radio

How do I get the best sound from Bluetooth headphones?



© WESTEND61/GETTY IMAGES

One of the most popular uses for Bluetooth is driving wireless headphones. Actually, “popular” might not be the right word: many reluctantly switched to Bluetooth headphones because their phone no longer has a traditional wired headphone adapter.

However, Bluetooth was designed for phone calls, and the creators were more worried about efficiency than sound. Accordingly, they chose an audio standard that required only lightweight encoding to provide comprehensible speech at low bit rates. This is the Sub-Band Codec—SBC for short—and it remains the baseline format for Bluetooth devices.

SBC isn’t useless, but it can sound mushy compared to an uncompressed source. It also suffers from latency as high as a quarter of a second, so it’s not suitable for real-time gaming, and won’t sync up properly with video content unless the host device adds a compensating delay.

The good news is that you’re not stuck with SBC. Bluetooth allows you to use any audio-streaming codec that’s supported by both the host and device, although there’s no standardization, so your options depend on the hardware you’re using.

For Apple devices, the alternative is AAC, the same compression format used by downloads from Apple Music. iPhones and AirPods use this by default, and although some quality is lost by re-encoding and re-decoding the music, the sound is better than SBC. However, AAC support on Android is patchy, making AirPods potentially risky for non-Apple users.

Android fans might be better off looking for aptX, a codec that’s similar to SBC, but delivers higher audio quality and lower latency. The HD variant promises “near lossless” sound, with bit rates up to 576Kbits/sec. The only problem is that these codecs are proprietary to semiconductor manufacturer Qualcomm, so you can only switch to aptX if both your phone and headphones use Qualcomm Bluetooth chips.

Another alternative is LDAC. Unlike aptX, this is open source, and supported by all modern Android devices. The downside is that having been developed by Sony, it’s mostly supported by Sony headphones.

If all these codecs confuse you, better times are on the way. The LE Audio profile, introduced in Bluetooth 5.2, includes a default codec called LC3. This is a big improvement on SBC: the Bluetooth SIG claims that in its own tests, listeners found LC3 almost indistinguishable from the source material, even at lower bit rates than SBC. Since it’s a part of the core Bluetooth standard, LC3 should be supported by future devices.

For now, if you want to see which codecs your Android phone supports, you can do so from the “Developer options” page in the Settings app. This is hidden by default—to make it visible, open the “About phone” page, and tap on “Build number”. Once you’re in the developer options, you should find an option entitled “Bluetooth audio codec”, which will bring up a menu from which you can browse audio formats. Be warned, though: if you connect a pair of headphones or a speaker that don’t support your chosen codec, they’ll likely fall back to SBC.

hardware, the intention being to allow IoT devices to use Bluetooth technologies over an internet or LAN connection.

2016 BLUETOOTH 5

The most recent major version of Bluetooth upgraded the performance of BLE, allowing data bursts of up to 2Mbits/sec within the low-power envelope. Alternatively, LE devices using Bluetooth 5 can establish longer-range connections at lower bit rates, making Bluetooth more viable as a platform for smart home appliances.

2019 BLUETOOTH 5.1

The next version of Bluetooth 5 continued to focus on range, with a new mesh connection mode that allows multi-hop connections to a host. We haven’t seen any real-world products that use this capability so far, but it could allow the personal area network to extend across a whole living space or office. A new angle-of-arrival feature was also added, allowing Bluetooth devices to detect the direction of incoming signals from paired devices, and hence perform basic location tracking.

2020 BLUETOOTH 5.2

Bluetooth 5.2 was a significant update, introducing the new LE Audio profile which promises higher-quality audio streaming with less power drain. LE Audio also includes the Auracast protocol, which allows a Bluetooth audio source to broadcast to an unlimited number of headphones or loudspeakers.

2021 BLUETOOTH 5.3

The latest release enables faster switching between performance modes, so devices can sleep when they’re not in use, then “wake up” almost instantly as needed. Bluetooth 5.3 devices can also detect radio interference and choose which radio channels to use—an improvement on the previous standard, where frequency hopping was managed solely by the host.

DISCOVER THE ALTERNATIVE TO APPLE AND WINDOWS

This is a treasure-trove of Linux and open source knowledge, from the evolution of Ubuntu and its mobile platform, to projects like automating your home with Raspberry Pi.

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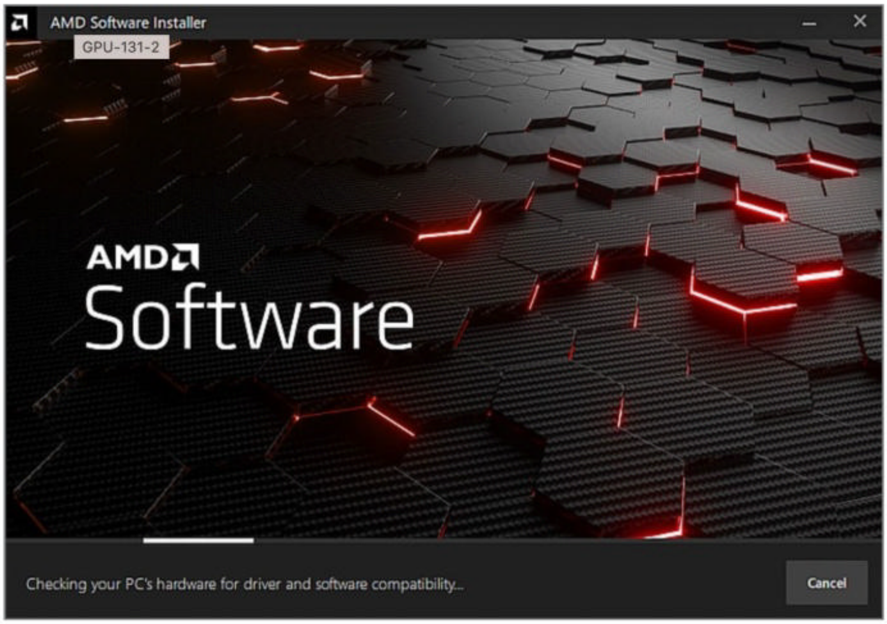
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

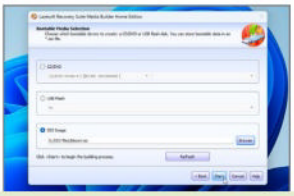
TIP OF THE MONTH



Checking your PC's hardware for driver and software compatibility...

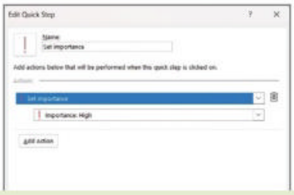
To ensure your AMD PC is running at its best, check out the AMD Auto-Detect tool. This app will keep your drivers updated for your Wi-Fi, Bluetooth, graphics, and chipset. It's peace of mind to know your system is up-to-date. Head to the AMD site to find out more.

MAKE – USE – CREATE



62
How to build a bulletproof rescue disk

66
Upgade your CPU to make your PC run faster



70
Manage email using Outlook's Quick Steps

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SAM LEWIS
STAFF WRITER

9 YEARS TOO LATE?

Despite writing for a predominantly Windows-based PC publication, you'd be surprised to find out that a favorite device of mine is my 2014 13-inch MacBook Pro. Yes, I know what you're thinking: why? Well, it's never let me down, been with me through all levels of education, was used to hand in potential career-changing essays, and is still comfortably usable. Granted, compared to the laptops I'm lucky to get my hands on, it's dwindling in performance, but it's the easiest to take with me on the go, and its sentimental value is huge.

Brief history lesson over, this model suffers from an anti-glare screen issue in which it looks as if someone has coated the display in hair spray. It's a common fault, and unknown to me, Apple actually offered a replacement offer for this, but that's been and gone now. Mine has suffered with this for most of its life, and it's taken until this week to find an actual at-home fix: baby wipes.

MacBook hacks aside, I've finally been able to try *Dying Light*. An Epic Games offer made this game free for a short period, and I've been thoroughly enjoying this 2015 title, especially on the new AMD 7950X3D machine I built along with its RTX 4090! Head to page 16 to check out how that build went.

↘ submit your How To project idea to: editor@maximumpc.com

Build a bulletproof rescue disk

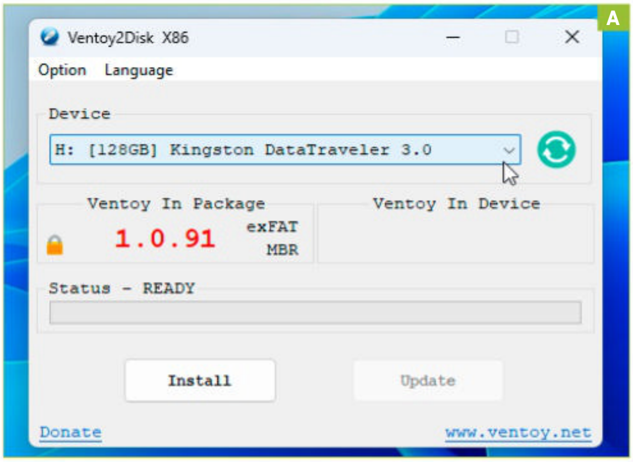
YOU'LL NEED THIS

16GB OR LARGER USB FLASH DRIVE
Ventoy (www.ventoy.net) and a selection of rescue media in ISO file format.

ONE RESCUE DISK TO RULE THEM ALL. That's the stated aim of this tutorial, and thanks to a free tool called Ventoy, that goal is not just reachable, it's simple to achieve, too. All you need is a suitably large USB flash drive—16GB or larger—and after installing Ventoy on it, you can simply copy across all kinds of bootable media as ISO files directly to the drive, then choose which one to boot from when you restart your PC.

Whether you need to restore your last drive image to bring Windows back to life, perform surgery on a non-booting Windows install, clear malware, or recover data from a corrupt drive before wiping it and starting again, your one-size-fits-all rescue disk will have you covered.

In this tutoial, we'll step you through the trickiest part of the process: installing Ventoy to your flash drive before configuring your Secure Boot-enabled PC to allow you to boot from it, then reveal some of the rescue media out there you need to ensure you've covered all your bases. While you're at it, why not chuck on some Linux live distros, too? Whatever your bootable media needs, Ventoy truly has you covered. **–NICK PEERS**


A
Ventoy2Disk X86
Option
Language
Install
Update
Donate
www.ventoy.net

Device
H: [128GB] Kingston DataTraveler 3.0

Ventoy In Package
1.0.91
exFAT
MBR

Ventoy In Device

Status - READY

1 INSTALL VENTOY

Ventoy doesn't require installation—you can download the latest version from its home page (https://ventoy.net/en/download.html) in one of two forms: as a standalone app packaged as a Windows zip file (right-click this and choose Extract All, then extract it to the same directory you downloaded it to), or as a Live CD (ISO) for those rare occasions when Ventoy is unable to write to your USB flash drive. There's also a build for Linux users.

» You can also install Ventoy in Windows via the PortableApps.com launcher—simply launch PortableApps Platform and choose 'Apps > Get More Apps > By Category'. You'll find Ventoy under Utilities, and the advantage of installing it through PortableApps.com is that it updates automatically.

» Once extracted or installed, plug in your USB flash drive and launch Ventoy (double-click Ventoy2Disk.exe if you downloaded it directly from the Ventoy website). After clicking Yes to grant Ventoy the necessary administrator privileges, the main screen should open as shown in [**Image A**].

2 CREATE VENTOY BOOT DISK

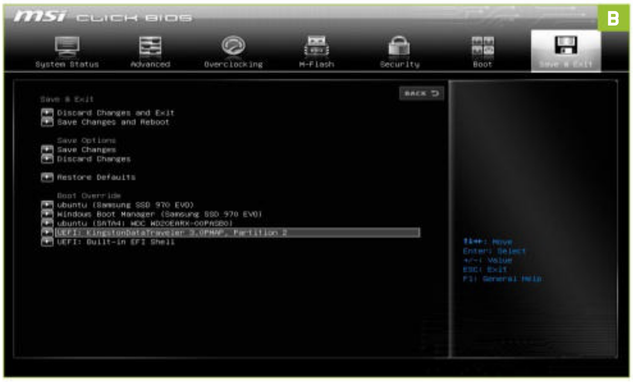
Make sure your flash drive is selected under Device (click the ˇ button to switch to it if a different drive is shown), then examine the 'Ventoy in Package' section. This tells you the current version, plus the partition layout (MBR) and file system (exFAT) for the Ventoy boot partition.

» Ventoy works by creating two partitions: a small hidden boot partition that loads it at startup, and then a larger partition into which you copy all your ISO files. We've had no problems using exFAT as the boot partition, so recommend that setting remains as it is. However, the MBR partition table is better suited to older BIOSes, so it's likely you'll need to switch to GPT mode.

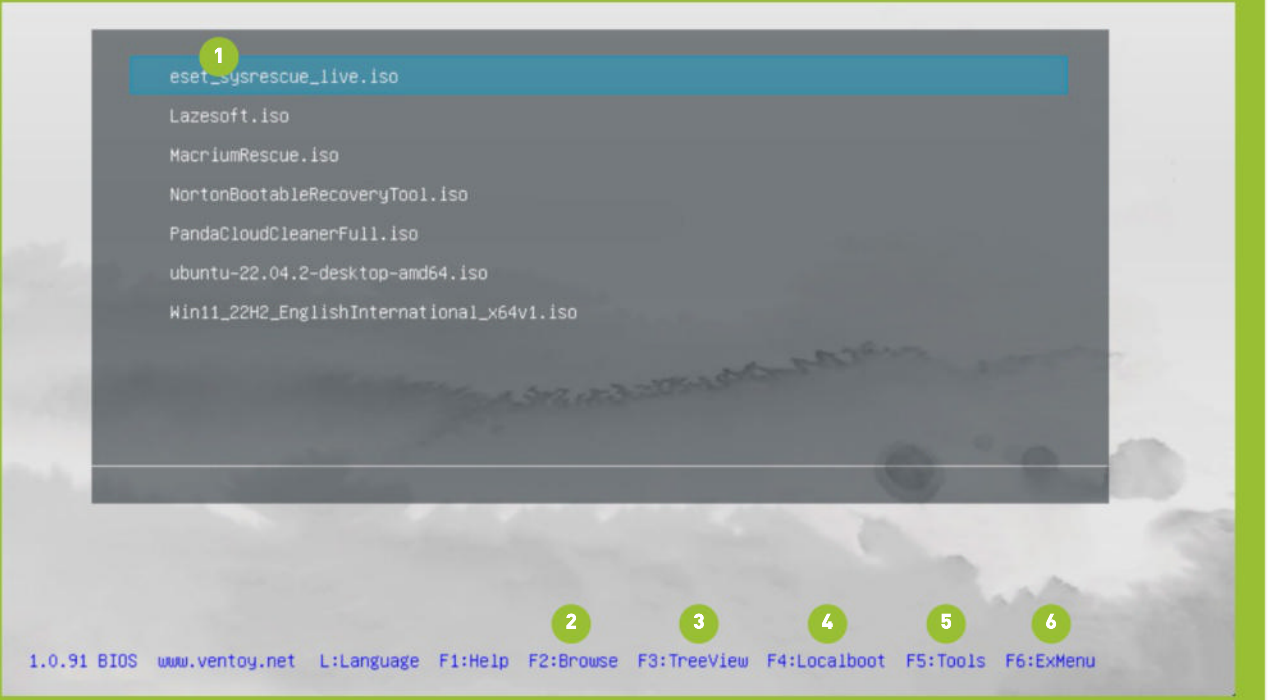
» Before doing so, press Win + R to bring up the Run dialog, type msinfo32 and hit Enter to open System Information. Under System Summary, check to see what BIOS Mode is set to—if it's UEFI, then you'll need to set your partition layout to GPT. While you're here, also check Secure Boot Start status to see if it's enabled on your machine.

» Return to the main Ventoy screen and open the Option menu. You'll see that 'Secure Boot Support' is checked by default—if your PC isn't protected by Secure Boot, you can uncheck this and save some extra legwork later. Next, open the Partition Style submenu and change it to GPT if required. Ignore the other options for now and return to the main screen.

» All that's left to do at this point is click the Install button, read the warning, and click Yes twice. This is a


B
msi CLICK BIOS
System Status
Advanced
Overclocking
M-Flash
Security
Boot
Save & Exit
BACK
Save & Exit
Discard Changes and Exit
Save Changes and Reboot
Save Options
Save Changes
Discard Changes
Restore Defaults
Boot Override
ubuntu (Samsung SSD 970 EVO)
Windows Boot Manager (Samsung SSD 970 EVO)
ubuntu (SATA4: WDC WD20EARX-00PASB0)
UEFI: KingstonDataTraveler 3.0PMAP, Partition 2
UEFI: Built-in EFI Shell
↑↓←→: Move
Enter: Select
+/-: Value
ESC: Exit
F1: General Help

THE VENTOY TOUR



```
eset_sysrescue_live.iso
Lazesoft.iso
MacriumRescue.iso
NortonBootableRecoveryTool.iso
PandaCloudCleanerFull.iso
ubuntu-22.04.2-desktop-amd64.iso
Win11_22H2_EnglishInternational_x64v1.iso
```

1. SELECT YOUR RESCUE DISK
All ISO files copied to your Ventoy flash drive will be here. Make your selection, then hit Enter to boot from that ISO file.

2. BROWSE
Press F2 to browse the contents of all locally attached hard drives from Ventoy—you can also boot directly from any ISO files you find on these drives too.

3. TREEVIEW
As your ISO file collection builds, consider organizing them into folders, then switch to TreeView to make them easier to find by browsing to a folder.

4. LOCALBOOT
Pressing F4 will exit Ventoy and boot from the first available hard disk on your system—typically your Windows drive—to return you to your desktop.

5. TOOLS
Access a range of useful features, such as Power (reboot or halt), or Temporary Control Settings, which includes an option to bypass CPU, TPM and SecureBoot checks to allow installation of Windows 11 on incompatible hardware.

6. EXMENU
This is a customizable grub2 menu you can fill with your own choice of grub2 commands—for example, options to boot directly to Windows or another installed OS. See www.ventoy.net/en/plugin_grubmenu.html for details.

destructive process—there is a 'Non-destructive Installation' option in the main Options menu should you wish to preserve existing data on the drive, but it won't work if you're intending to switch between MBR and GPT, or if the existing partition isn't NTFS (see www.ventoy.net/en/doc_non_destructive.html for a full list of conditions and potential workarounds—none of which are a substitute for copying the files off the drive, then copying them back on later if necessary, as any files can be stored on the drive alongside your ISO images).

3 ADD YOUR FIRST ISO FILE

Once Ventoy has installed itself to the flash drive, click OK to return to the main screen, where you should see the 'Ventoy in Package' and 'Ventoy in Device' fields now match. Whenever Ventoy releases an update, you can download and run the new version, verify that the 'Ventoy in Package' is newer than the version on your device, then click Update to update your flash drive without losing data. Updates add support for new ISO files as well as introduce features and squash bugs, but unless you have a particular issue, there's no need to update regularly.

» One final step: you need to test your bootable USB drive. To do so, you first need to copy your first bootable ISO file to it. Let's start with your drive imaging tool's rescue disk. This will enable you to restore the last system backup you took in the event of your PC failing to boot, transforming what might have been an unmitigated disaster into little more than a minor irritant.

» Those still running Macrium Reflect should open the program and choose 'Other Tasks > Create Rescue Media'. Make sure ISO File is selected, make a note of where the resulting file is saved (your downloads folder by default) and click Build to create the required files. Once created, click Close and copy the MacriumRescue.ISO file to your flash drive.

» Hasleo Backup Suite users should navigate to Tools and select Emergency Disk. Add any drivers you need or click Skip to build the emergency disk. Once it's in place, leave 'Export ISO' selected and click the folder button to set a destination and filename before clicking Proceed. Again, once finished, copy the file to your flash drive.

© MSI, VENTOY

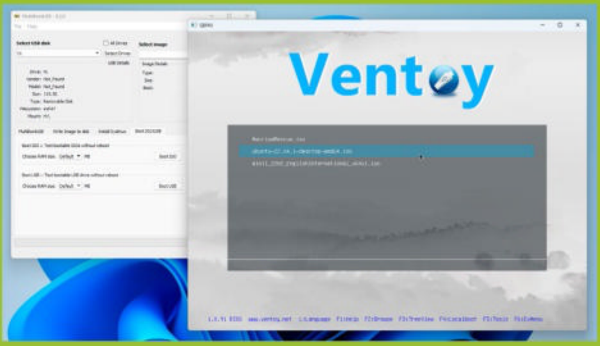
TEST WITHOUT REBOOTING

Rebooting your PC every time you want to test your Ventoy boot drive can be frustrating. While looking for a means to capture grabs of Ventoy, we stumbled on a quick way to test bootable USB drives—including Ventoy—in a virtual environment.

Head to https://qemu.weilnetz.de/w64/ to download the latest Windows 64-bit installer of QEMU—at the time of writing it was dated 2022-12-30. During installation, leave all options checked. Once it's in place, head to https://github.com/mbusb/multibootusb and click on Releases to obtain the last release (9.2.0) of MultiBootUSB (multibootusb-9.2.0-setup.exe).

Once installed, launch MultiBootUSB and verify that your Ventoy drive letter has been selected. Now, switch to the Boot ISO/USB tab and simply click 'Boot USB'—after a short pause a virtual window will open inside which Ventoy will launch. There may be a bit of screen corruption on the main menu, but it's still perfectly readable, and you'll be able to test away.

We still recommend testing Ventoy in a real environment—that's because many disks (like Ubuntu and Windows) won't load successfully in this basic environment, but also because it's a good idea to make sure the tools you've added work well with your system and hardware.



» Test Ventoy in a virtual QEMU environment.

4 TEST YOUR FLASH DRIVE

The moment of truth: it's time to test the drive. The box reveals a technique that allows you to test Ventoy in a virtual environment, but while that's useful when it comes to experimenting with settings, it's vital you test the drive on your actual PC, so you know you'll be able to rely on it should you need it.

» With the drive plugged in, restart your PC and look for the option on startup to either select the boot drive or—if it's not on offer—to enter the UEFI to look for a boot override option as shown in [**Image B**]. When your PC's boot manager appears, select your flash drive from the list—if two options are presented, pick whichever type (UEFI or MBR) matches the choice you made in step two.

» If your PC is set to Fast Boot, it's possible you won't see any option to select the boot drive during startup. In these circumstances, open Settings, navigate to System > Recovery and click Restart Now next to Advanced Startup. When your PC reboots, select 'Use a device' and select your USB flash drive from the list to boot from it.

» If Secure Boot is enabled, you will be presented with a blue error screen telling you that 'Verification failed (0x1A) Security Violation'. Hit Enter and press any key when prompted to perform MOK management. Select 'Enroll key from disk' and hit Enter. Select VTOYEFI and hit Enter, then select ENROLL_THIS_KEY_IN_MOKMANAGER.cer and hit Enter again. Choose Continue, followed by Yes, and then Reboot. When you next boot to the flash drive, you should see the main Ventoy screen appear.

» Note: you must perform MOK enrolment on each new PC that has Secure Boot enabled the first time you introduce your Ventoy rescue disk to it. However, it's a one-time only procedure for each PC—going forward, even if you recreate Ventoy on another drive, you won't need to re-enrol any MOK keys.

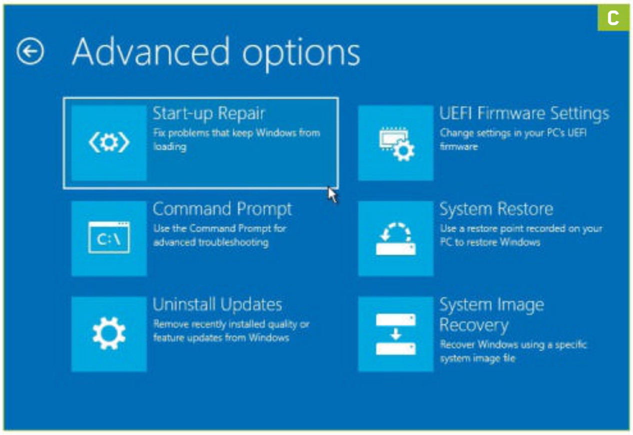
» If for any reason you're unable to enrol the key—you may find that your PC appears to freeze at this point—simply reset your PC. You should boot straight back into Windows. If you're unable to get the Ventoy boot disk to work with Secure Boot for any reason, recreate it with 'Secure Boot Support' disabled, then manually disable Secure Boot in your system UEFI/BIOS each time you need to boot from the disk.

5 BOOT FROM YOUR RESCUE DISK

By default, the main Ventoy screen displays a list of all ISO files placed on it. Selecting one is as simple as using the arrow keys followed by Enter—in this initial circumstance, only one option (Macrium or Hasleo) will be highlighted, so simply press Enter.

» Ventoy will now boot from this ISO as if you'd burned it to disc (or copied it to a standalone flash drive). With other bootable rescue media, you may be offered a secondary boot menu—for example, the Windows installation media offers to boot in normal or wimboot mode —in which case start with the normal option and then try various fallback options (Ubuntu offers a 'safe graphical mode', for example) if you're unable to get it to boot any other way.

» Once your chosen rescue environment has loaded, you should be able to use it in the same way as when booting from the rescue disk. If you run into specific problems—for example, it can't detect certain drives or you're unable to establish a wireless connection, you'll need to return to Windows and see if you're able to diagnose the problem. In many cases, you may need to provide additional drivers from your own PC setup to ensure the rescue media in question has access to the hardware it needs.



Advanced options

Start-up Repair
Fix problems that keep Windows from loading

UEFI Firmware Settings
Change settings in your PC's UEFI firmware

Command Prompt
Use the Command Prompt for advanced troubleshooting

System Restore
Use a restore point recorded on your PC to restore Windows

Uninstall Updates
Remove recently installed quality or feature updates from Windows

System Image Recovery
Recover Windows using a specific system image file

© MICROSOFT

6 ADD BOOTABLE INSTALLATION MEDIA

Next, we recommend downloading the latest version of the Windows installation disc, again in ISO format. Direct links are provided for both Windows 11 (www.microsoft.com/software-download/windows11) and Windows 10 (www.microsoft.com/software-download/windows10ISO). In both cases, a single ISO file is provided via the dropdown menu: it's a multi-edition version that covers Home, Pro and other versions.

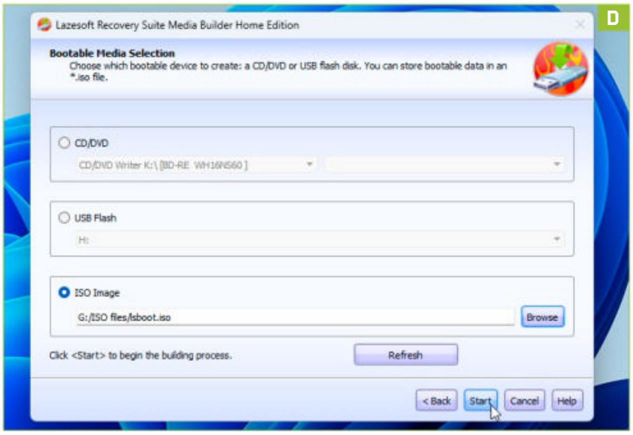
» Once downloaded, copy this file to your Ventoy boot disk (or both if you have machines running a mixture of Windows 10 and 11)—the Windows installation media doesn't just allow you to reinstall Windows from scratch, it also you access to Windows' repair tools, like Startup Repair and System Restore as shown in [**Image C**], which may help you recover your system after a crash.

» Now's also a good time to download and copy Linux installation media to your flash drive. We recommend choosing Ubuntu 22.04 LTS (https://ubuntu.com/download/desktop), as it can be run as a 'live' desktop environment directly from the flash drive. This gives you access to a desktop to access drives (to copy files off), access the internet, and more besides.

7 ADD MORE RESCUE TOOLS

Next, head over to www.lazesoft.com to download and install Lazesoft Recovery Suite Home Edition, which is completely free for personal use. The tool offers four main components, two of which stand out. The first is Windows Recovery, which offers a wider range of tools for repairing errors that cause Windows to crash or prevent it from booting correctly. The second, Data Recovery (which can also be launched from Windows), provides you with various options for recovering files from drives—including those that have gone missing, become corrupt or simply accidentally formatted.

» After installing Lazesoft, launch the program and click 'Burn CD/USB Disk' to open the Bootable Media Builder. Leave 'Same as this computer' selected as the Windows version, but only click Options > Add WinPE Drivers tab if you need to add specific SATA or RAID drivers to detect your hard drives—unlikely on most machines. Click Next, then select ISO Image and choose a convenient location to store the lsboot.iso file on your hard drive as shown in [**Image D**] before clicking Start. Again, once the ISO file is created, copy it across to your Ventoy boot drive.



Lazesoft Recovery Suite Media Builder Home Edition

Bootable Media Selection
Choose which bootable device to create: a CD/DVD or USB flash disk. You can store bootable data in an *.iso file.

○ CD/DVD
CD/DVD Writer K:\ [BD-RE WH16NS60]

○ USB Flash
H:

● ISO Image
G:/ISO files/lsboot.iso

Click <Start> to begin the building process.

8 THWART MALWARE

Many antivirus vendors offer emergency rescue media—ISO files that become bootable disks to scan compromised systems for forms of malware and remove them. Some vendors—like Avast—require you to create the media from within the program itself, while others, like Bitdefender and Windows Defender, can only be launched from within Windows, rebooting to their own rescue environment when requested or unable to clean the infection through normal means.

» Others, however, still provide bootable media for use outside Windows, which you can add to your Ventoy rescue kit. They include the Norton Bootable Recovery Tool (https://support.norton.com/sp/static/external/tools/nbrt.html), ESET SysRescue Live (www.eset.com/int/support/sysrescue/), and Panda Cloud Cleaner (www.pandasecurity.com/en/support/card?id=1681). Choose the DVD or ISO version rather than the USB.

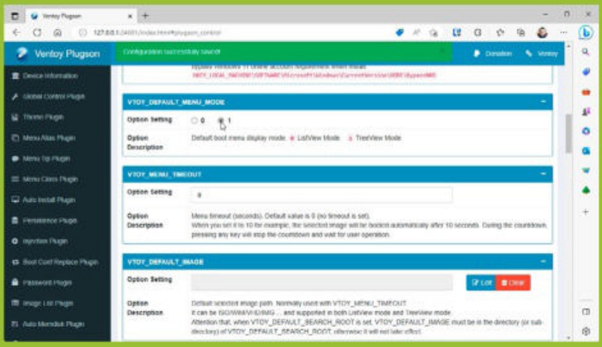
» Congratulations, you've just built your bulletproof rescue disk—but don't stop there, as you'll find lot of useful rescue media online, including the renowned Hiren's Boot CD (www.hirensbootcd.org), which bundles numerous repair and recovery tools in a single ISO file that boots to a Windows-friendly desktop. ⏻

CUSTOMIZE THE VENTOY BOOT MENU

If your boot menu starts to become crowded, there are several ways to make things easier to navigate. The simplest is to rename the boot files so they're more identifiable (for example, Norton Bootable Recovery Tool.iso rather than nbrt.iso).

Another tip is to group related ISOs together into folders, such as Security or OSes. By default, the Ventoy boot menu will continue to display these in alphabetical order, but if you press F3, you'll switch to TreeView, which as you'd expect, displays folders as well as files.

If you'd like to customize things further, you'll need to familiarize yourself with what Ventoy calls plugins, but which are in reality a series of text-based .json files. Thankfully, editing these doesn't involve your text editor—simply launch VentoyPlugsOn.exe from the same directory as Ventoy (or VentoyPortable\App\Ventoy in the PortableApps version), and it'll load a web page with access to all the tweaks you could possibly need. Visit https://ventoy.net/en/plugin_entry.html for a complete guide. One tweak to make TreeView the default view is to set VTOY_DEFAULT_MENU_MODE to 1 under 'Global Control Plugin'. You'll see Ventoy Plugson updates Ventoy in real time, so you can immediately test your tweaks using MultiBootUSB. Don't forget to click Stop in VentoyPlugson when you're done.



VTOY_DEFAULT_MENU_MODE
Option Setting ○ 0 ● 1
Option Description Default boot menu display mode. ListView Mode TreeView Mode

VTOY_MENU_TIMEOUT
Option Setting

VTOY_DEFAULT_IMAGE
Option Setting

» Ventoy's settings are held in plugins, all of which are editable.

© LAZESOFT

Upgrade your CPU for a faster PC

YOU'LL NEED THIS

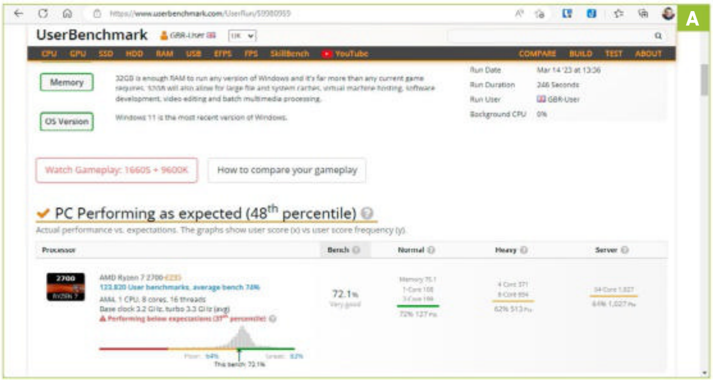
NEW CPU compatible with your current motherboard, plus thermal paste, and suitable cooler (new or repurposed). Isopropyl alcohol (90 percent proof) and cleaning cloth required for cleaning components.

IS YOUR PC STARTING TO SHOW SIGNS of age? Envious of the latest MaxPC kit but unable to afford the cost of a full system rebuild? The answer lies in upgrading your current system, and you can deliver a major uplift in performance by focusing on your CPU, a component often overlooked when upgrading your PC.

It wasn't that long ago that a new CPU inevitably meant a new motherboard, but these days, both Intel and (especially) AMD support the same socket architecture for at least two generations, making it possible—for example—to add a Zen3 CPU from 2022 to your 2018-vintage socket-AM4 mobo.

Even if you're unable to jump to a new generation, you may find wriggle room within your current CPU's generation. You might be able to upgrade to more cores and threads, along with a boosted clock speed to turbocharge such pastimes as gaming and HD/4K video encoding.

Upgrading your CPU is more involved than a simple RAM upgrade or hard drive swap, but we've got you covered in this tutorial. Read on to breathe new life—and new levels of performance—into your existing system, all without breaking the bank. **–NICK PEERS**



https://www.userbenchmark.com/UserRun/59980959

Windows 11 is the most recent version of Windows.

Run Date Mar 14 '23 at 13:36

Run Duration 246 Seconds

Run User GBR-User

Background CPU 0%

PC Performing as expected (48th percentile)

Actual performance vs. expectations. The graphs show user score (x) vs user score frequency (y).

AMD Ryzen 7 2700

AM4, 1 CPU, 8 cores, 16 threads

Base clock 3.2 GHz, turbo 3.3 GHz (avg)

1 ASSESS YOUR OPTIONS

Start by determining what CPUs your motherboard supports by first identifying its make and model—if you don't have this information handy, then download and install HWiNFO64 (www.hwinfo.com). Leave 'Summary-only' ticked and click Start. You'll see the make and model listed under Motherboard alongside information about the current BIOS version, as well as your CPU.

» Next, head over to your mobo manufacturer's website, locate your model's support pages, and in the compatibility section under CPUs, you will find a complete list of supported processors. This list is your definitive guide to what CPUs are supported, and should include details of which BIOS version is required to support the latest models. Compare this with what HWiNFO64 tells you—if your BIOS isn't up to date, follow your mobo manufacturer's instructions to update it to the latest version before proceeding further.

2 COMPARE DIFFERENCES

Which CPU you decide to go for is, of course, up to you. You'll be guided by your budget, as well as the performance jump you can expect. The annotation reveals what key things to look for in your next CPU.

» The simplest way to determine what kind of bump in speed you can get is to make use of benchmarking sites like UserBenchmark (www.userbenchmark.com)—simply Google your current CPU model plus 'versus', followed by one of the upgraded CPUs available to you. You should be able to access a site that will compare the two and reveal the differences in performance. If you want to go further, you can always benchmark your own system using a tool like UserBenchmark's free app, available via its home page. After the tests are performed, the results will be displayed in your browser [**Image A**], which you can then compare against your target CPUs.

» You might think the biggest gains to be had will come by transitioning from one CPU level (such as a Ryzen 3 or Core i5) to another (Ryzen 7 or Core i9), so even if you're unable to go to a more modern chip, you may still be able to get a decent bump through increasing the number of cores (and threads) available to you. In fact, even if you're currently running a higher-level CPU, there may be significant gains to be had if you're able to jump up a generation (say, from AMD Zen2 to Zen3, or Intel 12th gen to 13th gen). For example, we decided to upgrade our Ryzen 7 2700 to a Ryzen 7 5700X. This relatively simple switch promised an increase in performance of up for 40 percent for an outlay of around $190.

B
be quiet!
PURE WINGS 2
CORE BOOST

© USERBENCHMARK

3 FURTHER CONSIDERATIONS

Before diving in and purchasing your upgrade, there's one major thing to consider: the TDP (thermal design power) of your new chip. If you plan to continue using your current cooler, make sure it's rated for the new chip's TDP—in our example, both Ryzen 7 2700 and Ryzen 7 5700X come with a relatively low TDP of 65W. Even so, your new chip is likely to run hotter than your old one, so now might be a good time to upgrade the cooler so it can comfortably handle what you throw at it. In our case, while the Ryzen 7 2700's Wraith Spire cooler could—in theory—accommodate the Ryzen 7 5700X, we decided to upgrade it.

» Make sure your cooler is compatible with your CPU—some models like BeQuiet's Pure Rock Slim 2 (130W TDP) are rated for both Intel and AMD chips of a certain form factor, but others may only work with specific models. CPU coolers attach to your motherboard one of two ways: those that screw into the motherboard via spacers, and those that clip into place, like the Pure Rock Slim 2 as shown in [**Image B**]. You should also measure the dimensions of the cooler to make sure it'll fit inside your case.

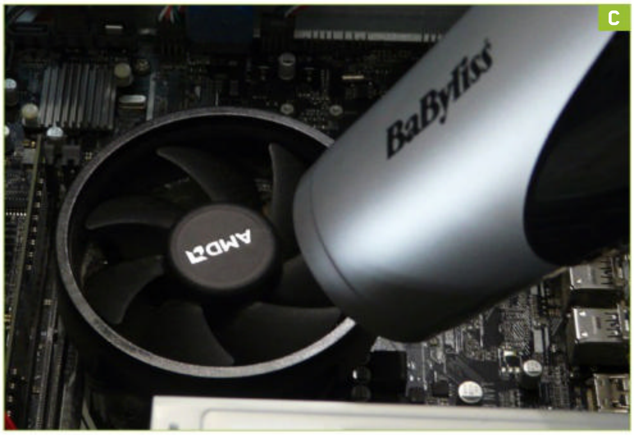
» Also, check to see if the cooler comes with its own thermal paste—the Pure Rock Slim 2 has a thin coat pre-applied to its base. Otherwise, you'll need to add another item to your shopping list in the form of some cooler paste. A syringe-based option is the easiest to apply.

» Last, but not least, review your current PSU: is it powerful enough to handle the new chip? Do some online research to see what size PSU is recommended for your CPU, and upgrade if required, particularly if you're switching from a CPU with integrated graphics to one with an external graphics card.

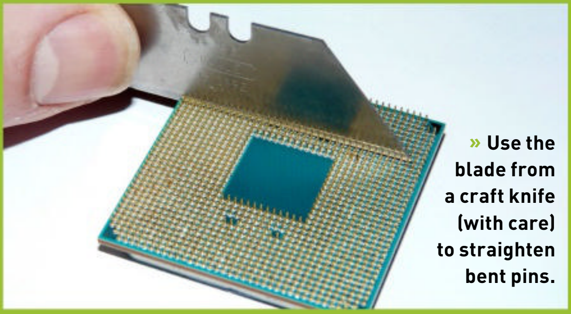
4 BEFORE YOU FIT YOUR NEW CPU

Your purchases have arrived, and you're understandably keen to get on with the task of upgrading your CPU. But as always, an ounce of preparation is worth a pound of care. Start by looking inside your case to locate the CPU and cooler, and determine how it all connects. Sadly, you can't simply shut down your PC and just whip off the cooler before removing the CPU—there's a good chance (particularly with AMD chips and stock coolers) that the cooler is practically welded to the CPU via its thermal paste.

» Once you've ascertained what needs to be done to remove the cooler and CPU, gather your tools—a small Philips screwdriver if the cooler is screwed in, or a small flat-bladed screwdriver if it's clipped on. Now power on your PC and—to help loosen that paste—indulge in some processor-intensive activity to bring up the CPU temperature. Play a game, encode some video or benchmark your PC using a tool like Cinebench R23 (www.maxon.net/en/cinebench).



STRAIGHTEN BENT CPU PINS


» Use the blade from a craft knife (with care) to straighten bent pins.

If your CPU and cooler came out as one, you need to separate them if you plan to reuse either (or both). Start by placing the cooler/CPU combo upside down so the CPU is facing upwards, showing its pins. Now, use a hairdryer to heat up the heatsink, loosen the thermal paste, and make things easier to remove.

If you're unable to twist the CPU off the base of the cooler, take the blade from a craft knife (with care—we cut our thumbs in a moment of madness!) and insert it underneath one corner of the processor, blades facing forward. Try wriggling the blade into the gap to loosen more of the thermal paste. You may need to attack more than one side before you're able to prise off the CPU.

Once the CPU is free, examine its pins carefully to see if any are bent—they're relatively easy to spot. You can make use of the same craft knife blade—cleaned up first, of course—to gently place it within the gap between each row of pins. Gently push it through past the bent pins, then wriggle it carefully to straighten the pins in that direction. You may also need to run the blade down the opposite path to finish the job.

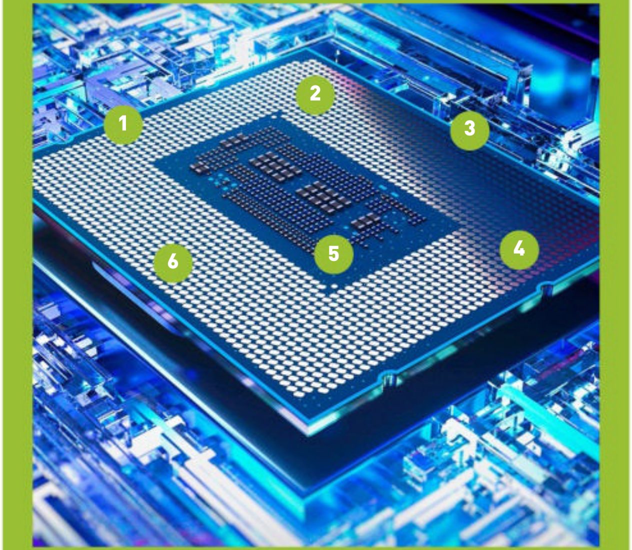
5 REMOVE THE OLD COOLER

Once you've heated things up nicely, power down your PC. Completely unplug it and place the case on a suitable flat surface like a table at waist height with a good light source to help you see inside. Take precautions to ground yourself and avoid antistatic electricity before opening it up. First, unclip any cooler cables—typically power and RGB—connected to the motherboard. Now, the aim is to remove the cooler without pulling out the CPU at the same time.

» If your cooler is screwed into the motherboard, work in a diagonal pattern and turn each screw counterclockwise, around five turns at a time, until you feel them come free of the retainer. If it's attached using clips, pull up the lever carefully to switch them to the unlocked position. Unhook the clips.

» Stock Intel coolers come with four plastic retaining screws. You need to turn each one in the direction of the arrow (use a flathead screwdriver or—at a push—a paperclip)—a quarter turn should be sufficient to loosen the screw. Once all four screws have been loosened, pull up each screw. Some force may be required, but you'll hear a click when it comes free.

YOUR CPU CHECKLIST



1. CORES/THREADS
The more cores a processor has, the better it is at multitasking and processor-intensive tasks. These days, even entry-level Ryzen and Core chips come with four cores.

2. CLOCK SPEED
A CPU's speed—or core frequency—is measured in GHz. Two figures are provided: base and turbo. Base is its everyday level, and turbo is what it's capable of, subject to thermal and power limits.

3. OVERCLOCKING
A CPU's ability to increase its clock speed to a higher frequency than recommended by the manufacturer. This results in more heat, and thus requires better cooling.

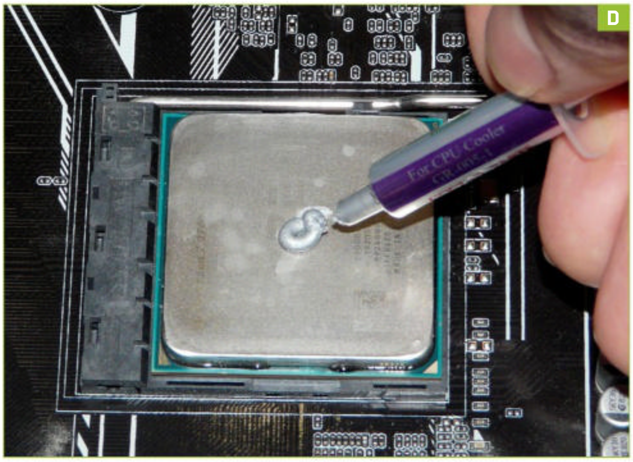
4. TDP (THERMAL DYNAMIC POWER)
The maximum amount of heat a processor generates. Lower TDP requires less cooling, but typically results in a lower base frequency.

5. SOCKET
This refers to the physical socket a processor plugs into on a motherboard. The latest sockets used are AM5 (AMD's Zen4 chips) and LGA 1700 (Intel's 12th and 13th generation CPUs).

6. CACHE
This is a CPU's specialist storage, designed to speed up the processor's ability to access data from the RAM. Multiple levels (L1, L2, L3, and occasionally L4) are provided. The more cache, the better.

» From here, you need to gently twist the cooler clockwise and counterclockwise, or try rocking it in a circular motion to loosen the thermal seal connecting the CPU to heatsink—the hotter the heatsink at this point, the less rigid the seal. If it doesn't come away easily, get a hairdryer and blow it over the heatsink until it feels almost too hot to touch, as shown in [Image C] , then continue twisting gently.

» The trick is to resist pulling, but focus on twisting, even if there's some resistance at first (in which case keep applying the hairdryer). You might even want to consider removing the fan from the heatsink—look for retaining screws if so—to make it easier to get at the heatsink.



© INTEL, AMD

6

SWAP OUT OLD CPU FOR NEW

In an ideal world, the cooler will eventually come off to leave the CPU in place. If this happens, you can then flick up the retaining clip next to the CPU and remove it carefully from the mobo. If the CPU comes off with the cooler, check out the box opposite to separate and clean the two if you plan to reuse or sell on either component.

» Next, turn over your new CPU and note the pin alignment—AMD CPUs feature an arrow that reveals the square-shaped corner that will fit only one way on your motherboard, for example. Be sure to align this with the correct pin alignment before dropping it in carefully, verifying that it's in place, and then securing it—typically with a clip, but also sometimes with an additional plate.

» Now, unless your cooler comes with its own thermal compound, place a small amount of thermal compound—around the size of a pea—on the center of the CPU, as shown in [Image D]. This is more easily achieved using a syringe.

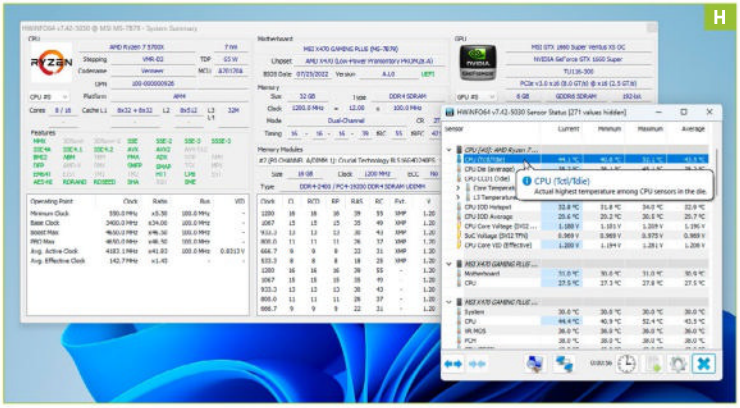
7

FIT COOLER

Next, if necessary, fit the retainer for your clips or screws depending on your cooler type. A clip-based retainer easily screws into the holes on the motherboard—just be sure that the notches are facing outwards, as shown in [Image E]. A screw-based retainer may be trickier—this needs to be mounted from underneath the motherboard, which almost certainly requires you to remove the other side of your case to gain access. You'll need to hold the retainer in place—tilt your case slightly to get your hand underneath to keep it in place while you proceed with the next step.

» Your cooler needs to be lined up to fit into the retainer—whether screw holes or clip brackets. Typically, it can only fit in one of two directions. Fan placement is key here—either replicate your previous configuration or ensure the fan is blowing hot air away from the air intake (where cool air is drawn in, typically by a case fan). If the fan is mounted vertically, then positioning is simply a case of ensuring the cooler's power cable can easily reach the CPU_FAN header on the motherboard and—if applicable—your RGB power cable can reach, too.

» Now, either fit the clips over the little notches before using the lever to tighten them, or tighten each screw—again going diagonally, and not tightening all four



screws until they're all in place and have gripped the retainer's screw holes (at which point you can stop supporting the retainer with your hand). Don't over-tighten the screws—this may prevent your PC from booting, or could result in strange errors like CPU fan error or overvoltage error.

» Finally, plug in the cooler's cables. Make sure this goes into the CPU_FAN header and not a chassis or system header; some motherboards complain loudly if they can't detect anything connected to the CPU_FAN header.

8 TEST NEW CPU

Leave the cover off, and connect your PC to power, monitor, and a keyboard. Power it on. If all is well, you should see your POST messages—press the key prompted (typically Del or F2) to enter your BIOS and confirm the new CPU has been detected correctly. Make a note of the CPU temperature—it should be relatively low (25-40 degrees Celsius), indicating that your cooler is also correctly installed. You can now replace the case covers, reattach everything else, and reboot into Windows. Use HWiNFO to monitor your temps over the next few days to see how your new setup is performing as shown in [**Image F**].

» If the temperature is running hotter than you expect, it's worth removing the cooler and checking you've applied enough thermal paste—a thin veneer should cover the top of the CPU as well as the plate on the heatsink. Remember, though, that too much as well as too little can cause problems. If you upgraded your CPU but kept your old cooler, you may also decide that the cooler isn't powerful enough for your needs, in which case you should upgrade to higher-rated TDP model sooner rather than later.

» Once your system is up and running smoothly again, now is the time to run that updated benchmark—use the same tool you used previously, whether that's UserBenchmark or Cinebench R23. Make a note of how much quicker your new CPU is—you should be able to confirm this in real-world tests, from encoding HD video to playing your favorite games. Congratulations—you just gave your PC a major speed boost without breaking the bank! ⏻

WHAT TO DO WITH YOUR OLD CPU

One of the reasons we decided to upgrade our CPU was because it meant two upgrades for the price of one: our main PC got boosted to the Ryzen 7 5700X, while another PC was able to jump from the Ryzen 3 2200G to the Ryzen 7 2700. We had to repurpose an old discrete graphics card (GeForce GT 1030) to replace the Ryzen 3's 2200G's onboard graphics so we could free up the system's meagre 8GB RAM exclusively for Windows. The upgrade came with two further benefits: a 30 percent speed bump, and the Ryzen 7 2700 supports Windows 11, allowing the PC to be bought bang up to date.

If you decide to follow our example, then simply follow the same CPU upgrade procedure for your older PC once your new one is in place. You'll need to clean off any thermal paste from both CPU and cooler of course—do this by applying some 90 percent-pure isopropyl alcohol to a lint-free cloth or paper towel, then gently rub on the CPU and cooler's heatsink to bring them back to their shiny best, ready for fitting or alternatively to sell on a marketplace like eBay to recoup some of your outlay.

» **Clean off thermal paste with 90%-pure isopropyl alcohol.**

Manage email using Outlook's Quick Steps

YOU'LL NEED THIS

MICROSOFT 365 SUBSCRIPTION, OR OUTLOOK 2013 OR LATER
Copy style of what's needed.

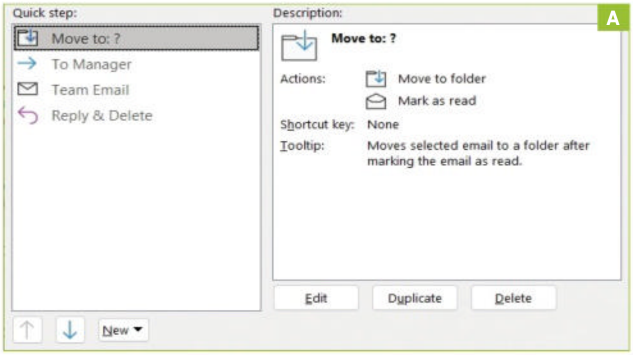
MANAGING YOUR EMAIL CAN BE A FULL-TIME JOB. It can take hours to sort, especially if you get a lot of messages that need forwarding, dealing with another time, or deleting.

This is something that email developers are trying to fix. They realise that streamlining the process is likely to win a host of new users. Outlook's approach is a tool called Quick Steps, which lets you join a series of tasks that can be executed in sequence with a keyboard shortcut.

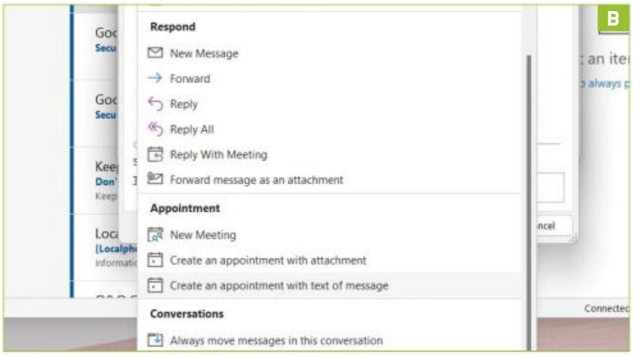
The process works like macros, which you may have heard talked about in relation to documents, spreadsheets, and attachments. That's because, like a sequence in Quick Steps, macros are series of commands that execute automatically in a given order. However, because macros are built by hand using a programming language, they can perform a wider range of tasks than Quick Steps, which are restricted to functions that are already part of Outlook.

This is both a benefit and a challenge. Since macros are more flexible, they're also more powerful, so hackers could use them to steal data from your PC, or even delete it in bulk. Quick Steps can't do this, although they can be used to delete messages if you set them up that way.

Here, we'll show you how to set up three Quick Steps sequences to keep your inbox in order. Before you get started, make sure Quick Steps is visible on the ribbon toolbar. If Outlook is set to show the simplified toolbar, right-click it select Use Classic Ribbon to reveal the panel. Then, click the square icon below the panel to pop out the full Manage Quick Steps box. **–NIK RAWLINSON**



Actions: Move to folder
Mark as read
Shortcut key: None
Tooltip: Moves selected email to a folder after marking the email as read.


B
Respond
New Message
Forward
Reply
Reply All
Reply With Meeting
Forward message as an attachment
Appointment
New Meeting
Create an appointment with attachment
Create an appointment with text of message
Conversations
Always move messages in this conversation

1 PUT OFF REPLYING TO AN EMAIL UNTIL LATER

If you can't deal with a message right away, you could mark it as unread and come back to it later. However, doing that means you risk forgetting it as it gets pushed further down your inbox by other incoming messages. This Quick Steps sequence adds it to your tasks list so you'll be reminded to deal with it before it's due.

» Click 'New' in the Manage Quick Steps box [**Image A**], then click Custom on the menu. Select the placeholder text in the Name box and change it to Put off until later, or whatever makes the most sense to you. It doesn't matter what you add here: it's just used to distinguish this Quick Steps sequence from any other you create.

» Click the 'Choose an Action' menu and select 'Create a task with text of message' [**Image B**]. Note that above this there's a similar option to 'Create a task with attachment', which adds your email and all of its content to the appointment you're going to make. If the message includes attached documents or images, this may be a more appropriate option in certain circumstances.

» Click the menu beside 'Shortcut key' and select 'CTRL+SHIFT+1' [**Image C**] from the options. Using this combination will trigger the Quick Step, even if you switch back to the simplified Ribbon menu, from which you won't be able to click the Quick Step directly. You have the option to write a short description in the 'Tooltip text' box, then click Save.

» Click OK to close the Manage Quick Steps box, then select a message and press Ctrl+Shift+1 on your keyboard. This creates a new task in Outlook with your message and, crucially, the 'from' address that you'll be able to click to reply to when the task pops up. Tick the box beside Reminder and select the date on which you want to be reminded to deal with the email [**Image D**], then click 'Save & Close'.

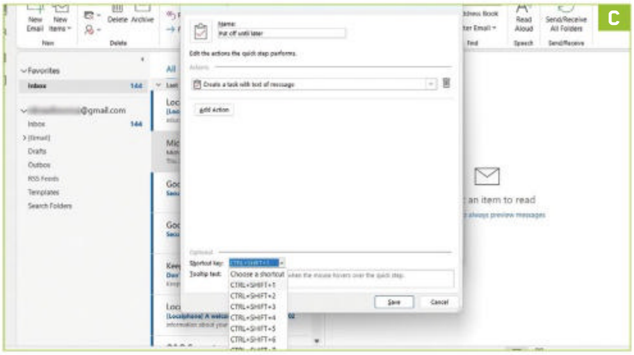
2 OPT OUT OF A LONG EMAIL THREAD

When email threads start getting out of hand, the healthiest course of action can be to send a quick reply, then opt out.

» This Quick Step sequence does just that, allowing you to explain why you'll be disappearing from the discussion, then ignore any further contributions to the ongoing thread.

» Click 'New' at the bottom of the Manage Quick Steps box, then click Custom on the menu. Give your sequence

© MICROSOFT

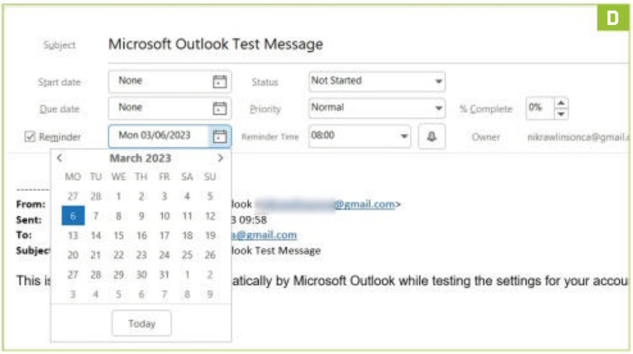

C
Delete
Archive
All
Address Book
Filter Email
Read Aloud
Send/Receive All Folders
Favorites
Inbox
Drafts
Outbox
RSS Feeds
Templates
Search Folders
Add Action
Optional
Choose a shortcut
CTRL+SHIFT+1
CTRL+SHIFT+2
CTRL+SHIFT+3
CTRL+SHIFT+4
CTRL+SHIFT+5
CTRL+SHIFT+6
Save
Cancel
an item to read

Name: Put off until later

Edit the actions the quick step performs.

Create a task with text of message

Shortcut key: CTRL+SHIFT+1



Subject: Microsoft Outlook Test Message

Start date: None

Status: Not Started

Due date: None

Priority: Normal

% Complete: 0%

☑ Reminder: Mon 03/06/2023

Reminder Time: 08:00

Owner: nikrawlinsonca@gmail.

March 2023

MO	TU	WE	TH	FR	SA	SU
27	28	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

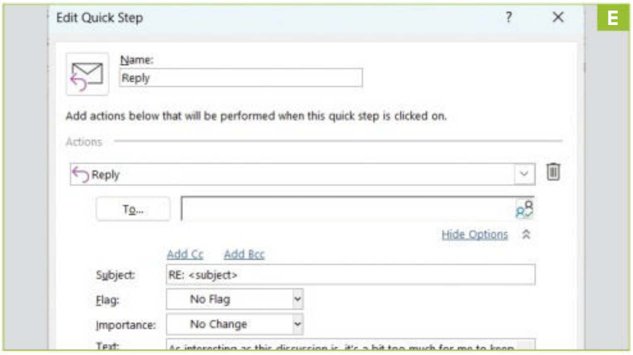
From: look @gmail.com>

Sent: 3 09:58

To: a@gmail.com

Subjec look Test Message

This is atically by Microsoft Outlook while testing the settings for your accou


E
Edit Quick Step
?
×
Actions
To...
Hide Options
Add Cc
Add Bcc

Name: Reply

Add actions below that will be performed when this quick step is clicked on.

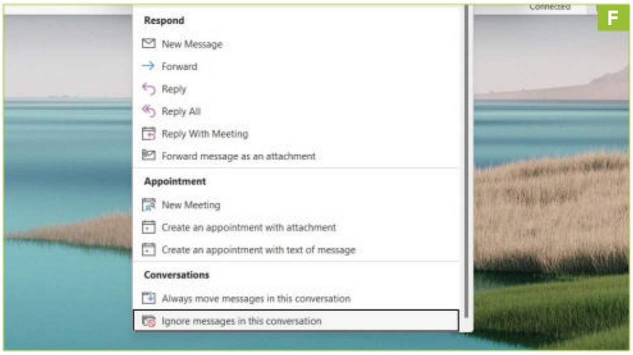
Reply

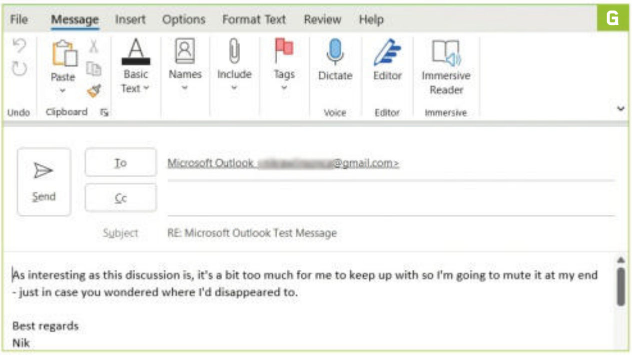
Subject: RE: <subject>

Flag: No Flag

Importance: No Change

Text: As interesting as this discussion is, it's a bit too much for me to keep


F
Connected
Respond
New Message
Forward
Reply
Reply All
Reply With Meeting
Forward message as an attachment
Appointment
New Meeting
Create an appointment with attachment
Create an appointment with text of message
Conversations
Always move messages in this conversation
Ignore messages in this conversation

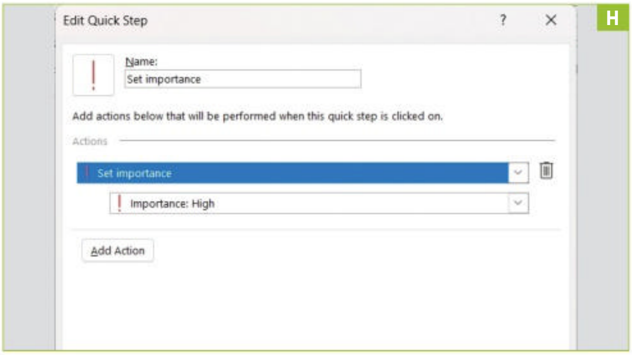

G
File
Message
Insert
Options
Format Text
Review
Help
Undo
Paste
Clipboard
Basic Text
Names
Include
Tags
Dictate
Voice
Editor
Editor
Immersive Reader
Immersive
Send
To
Cc

To: Microsoft Outlook @gmail.com>

Subject: RE: Microsoft Outlook Test Message

As interesting as this discussion is, it's a bit too much for me to keep up with so I'm going to mute it at my end - just in case you wondered where I'd disappeared to.

Best regards
Nik


H
Edit Quick Step
?
×
Actions
Add Action

Name: Set importance

Add actions below that will be performed when this quick step is clicked on.

Set importance

Importance: High

a name, then select Reply from the Actions menu [**Image E**] and click Show Options. Write the body of your email in the Text box, remembering to keep it generic so it can be applied in any situation, whatever the ongoing email thread is about.

» Next, click the Add Action button, followed by the 'Choose an Action' menu, and select 'Ignore messages in this conversation' [**Image F**]. What you're doing here is joining two actions so they can be triggered with a click of this Quick Step in the Quick Steps panel, or using a keyboard shortcut.

» Click the 'Shortcut key' menu, and this time select 'Ctrl+Shift+2', then optionally add some tooltip text, and click Finish.

» Test your sequence by selecting an email and pressing Ctrl+Shift+2. This creates a new email with the email address (or addresses) of the senders and your pre-written text [**Image G**]. Click 'Send' to dispatch it.

3 DELEGATE RESPONSIBILITY FOR AN EMAIL

If you're keeping watch on the inbox for a small business or club, you won't necessarily be the best person to deal with all the emails you receive. With Quick Steps, you can easily delegate tasks to other club members and change their importance to make them stand out.

» Click 'New' at the bottom of the Manage Quick Steps box, then click Custom on the menu. Give your sequence a name, then choose 'Set importance' from the Actions menu. Leave the menu that appears below this set to 'Importance: High' [**Image H**] above), which is the default option. Click 'Add Action', and select 'Forward' from the list of options. This adds an extra layer of options to the box where you can enter the recipient's email address.

» If you'll always be sending the message to the same person, enter their address in the To box, then click Show Options and tick the box beside 'Automatically send after 1 minute delay'. If not, leave the To box empty and don't click the box.

» If you want to assign a keyboard shortcut to your sequence, click the 'Shortcut key' menu and select CTRL+SHIFT+3, then click Finish. To test your new sequence, select an email and press Ctrl+Shift+3 on your keyboard.

» If you didn't enter an email address when defining the sequence, type one on the To line, then click Send [10] to delegate responsibility for the email to someone else.

LAB NOTES

GUY COCKER, EDITOR-IN-CHIEF

End the bad PC ports

The worst year in history for PC game ports—just five months in!

THERE HAVE BEEN SOME TRULY AWFUL PC game ports—*Batman: Arkham Knight*, *Dark Souls: Prepare to Die Edition*, and the original *Resident Evil 4* all spring to mind. But 2023 will go down as the worst year yet for lousy PC versions of great games—and we're not even halfway through the year yet.

The Last of Us Part I turned one of the greatest games ever made into a laughing stock on PC, with a shader compilation process that took longer than Steam's allotted refund time, and bugs that turned the famously serious game into an outright comedy. One month on, and it's still not fixed. *Wild Hearts* is similarly unplayable, with the top review on Steam stating: "The price is higher than the FPS you will be able to pull in this game." Funny, except for those who bought it in good faith.

This month's review game, *Star Wars Jedi: Survivor*, suffered a similarly ignominious launch. There's a brilliant game in there, but not one that I would recommend to PC players, even if they have a cutting-edge system. When I played it on a gaming laptop with an i7-12700H and RTX 3070Ti, I couldn't get the average frame rate above 45 fps, and that's with settings on low. It appears as though the open world setting and streaming of assets is unoptimized, so no matter what visual settings you use, the frame rate will never be smooth. EA's response: "[the game] isn't performing to our standards for a percentage of our PC players" and actually blamed gamers with high-end hardware as the problem.

Unlike consoles, submitting PC games to Steam or Epic Games Store doesn't require the same quality control—I would love to see these retailers being more stringent on what they will accept. Some punishment for repeat offenders like EA would also be welcome. Right now though, everyone is being hurt by this, especially the likes of Nvidia and AMD, who are selling expensive GPUs to buyers who can't even run the latest PC games when they come out.

Star Wars Jedi: Survivor won't run well enough for me to play it.

© RESPAWN ENTERTAINMENT

SAM LEWIS

Staff Writer

When I write, a laptop is a far more convenient and efficient option over a fully fledged and overkill desktop PC. I know, don't hate me! I'm talking more about practicality here—I can just pick one up and carry on where I left off. Anyway, the bottom line is I get to use a lot of laptops and I don't tend to chuck out any of my old tech, so over the last week or so I thought I'd give them some well-deserved TLC for all the hard work they've put in over the years.

This started with my old 2014 MacBook Pro, which I mention in this issue's How To column. I removed the anti-glare layer that ruins the screens from these specific models, opened up the back case, and gave it a clean. This thing was filthy, so with a can of compressed air, Q-tips, and some small brushes, I carefully went around the PCB and fans to clean it. I then took the heatsink off the CPU, cleaned it up using isopropyl alcohol, and applied a drop of thermal paste. This very quickly improved the thermal performance of this MacBook and reduced fan noise.

It then resulted in me applying this same method to all of my other laptops, and yes, they were equally in need of a spring clean. So, if like me, you have never done this before, it's well worth purchasing a PC/laptop servicing toolkit and cleaning out your system. It goes without saying, but take your time and be very careful.

OLED monitors have the edge for HDR thrills, but they can't match the precision of a 4K panel like the Lenovo Legion Y32p-30

Editor's Pick:
Lenovo Legion Y32p-30

Great both as an investment and as an OLED monitor for daily use

IN MANY WAYS, the Lenovo Legion Y32p-30 is on-paper perfection. What's not to like about 32 inches of 4K, 144Hz, and 0.2ms refresh goodness? The fact that for similar money, you have various options, one being a 48-inch 4K OLED monitor from Gigabyte: the Aorus FO48U.

I say "monitor"—it is really a repurposed LG TV. What it can't do is match the pin-sharp, crispy image quality of a 32-inch 4K panel. That's the attraction of the Lenovo Legion: the high pixel density combined with 144Hz refresh. It's a recipe for not only epic in-game visual detail, but also lovely fonts. It's everything you'd want in a premium PC monitor.

Indeed, it's the high-DPI thing that no current OLED PC monitor can match. At best, you're looking at about 110DPI with an OLED PC monitor. This Lenovo's 140DPI is a step up. Of course, this isn't the only 32-inch, 4K high refresh monitor in town, but it does stand out, courtesy of the aforementioned 0.2ms refresh.

That's what Lenovo claims, but it's via the MPRT response metric, which makes it a little misleading. In fact, Lenovo only claims 2ms by the more representative gray-to-gray measure of pixel response, which is more in line with IPS technology.

As IPS screens go, this is quick. Yes, an OLED panel is faster, but the subjective experience isn't that different. Where OLED has an advantage is contrast and HDR performance—speaking of which, the Lenovo Legion Y32p-30 has local dimming support, but only 16 edge-lit zones.

In reality, that's a checkbox feature, which helps with HDR certification, but does little to improve the real-world experience. Games and other HDR content look more punchy than conventional SDR images, but only a little. Bottom line: the black levels and HDR performance are very poor compared to an OLED monitor.

While we're talking HDR, it's worth noting that the Lenovo Legion Y32p-30 doesn't do SDR content well in HDR mode, which is annoying, because you have to constantly toggle back and forth between image modes. Better calibrated displays can do SDR content perfectly in HDR mode, allowing you to leave a screen there.

That aside, this is a pleasing panel for broader SDR duties. The colors are vibrant without being oversaturated, and the 4K resolution on a 32-inch diagonal makes for oodles of desktop elbow room and nice, crisp fonts at the same time.

The 144Hz refresh keeps latency to a minimum—if you have the graphics firepower to drive this screen at high frame rates. Mercifully, GPU prices continue to head in the right direction, but it's worth remembering that pushing a 4K screen above 100 fps in the latest games is a tall order, even with a powerful graphics card.

In that context, the Lenovo Legion Y32p-30 is best viewed as a long-term investment. You might not get the best out of it on day one, but in three years, 32 inches, 4K, and 144Hz will still be a killer combo, and a GPU that can get it moving will hopefully be a lot more affordable.

Long story short, there's lots to like about the Lenovo Legion Y32p-30. It ain't cheap, and the HDR support is patchy. But the feature set, including not only DisplayPort 1.4 and HDMI 2.1, but also USB-C with 75W of power delivery, is bang on. The build quality is excellent, and the image quality is mostly excellent. If you're in the market for this kind of panel, you won't be disappointed. **–JL**

$750, www.lenovo.com

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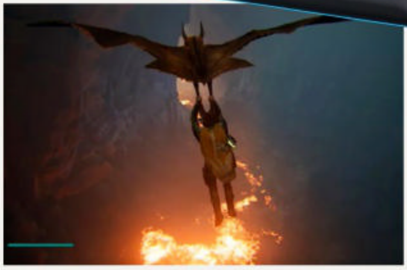

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AMD
RYZEN
AMD Ryzen 7 7800X3D
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BS 2305PGY
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No jack of all trades, but a master of one: gaming.

AMD Ryzen 7 7800X3D

The best gaming processor AMD has ever produced

THERE IS A VERY STRONG argument to be made for the AMD Ryzen 7 7800X3D being the best gaming CPU around right now. It's certainly the best gaming chip that AMD has ever made, but it's also capably outperforming Intel's top CPU when it comes to gaming frame rates, and is doing so for a lot less cash. It's a lot less thirsty, too.

That's possibly one of the most intriguing things about the 3D V-Cache processors of the Zen 4 generation—just how much more efficient they are than the first top-end chips of the Ryzen 7000-series. In fact, with every subsequent release of this new generation, AMD has improved its latest processor range, making the previous ones almost redundant.

The Ryzen 9 7950X3D, reviewed in our May 2023 issue, offers a mix of high-end gaming performance and a full 16 cores of Zen 4 processing. But its hybrid design, which offered one eight-core chiplet (or CCD) with the extra 64MB of L3 cache fused on top of it and another CCD without, demanded some extra hoops for the operating system to jump through, and sacrificed some of a standard 16-core chip's raw multithreaded performance.

The Ryzen 7 7800X3D, however, is as straightforward as AMD's 3D V-Cache gets. There's one eight-core chiplet with extra cache, and no messing around with provisioning or applications scratching their heads to figure out which of the big CPU's CCDs it ought to be using.

So does that make it a better gaming chip? Well, it's not necessarily faster—highlighting how well AMD delivered on the 7950X3D's hybrid design—but it makes more sense as the CPU at the heart of your gaming PC. Simply put, if you want the absolute highest gaming frame rates, and don't care for the CPU-intensive distractions of rendering or encoding, then AMD's chip is the processor for you. It wears its gaming predilections on its sleeve, and delivers performance that could make a Core i9 blush.

It's seriously efficient, too, and that combination of gaming power and low electrical power makes this new 3D V-Cache processor a tantalising choice for your gaming rig. Now that AMD's AM5 platform has matured, we're finding more affordable motherboard options every day, and DDR5 memory and PCIe 4.0 SSDs seem to be constantly dropping in price as well.

The headline for gamers is that the 7800X3D can deliver at worst the same gaming frame rates as both of the most expensive processors in the business—the Ryzen 9 7950X3D and the Intel Core i9 13900K. This is hugely impressive, especially considering it's nominally far slower than both in terms of clock speeds.

Switching from gaming to more creative/productivity apps and you can see why we're talking about this as a gaming-focused processor. Sure, it's got the edge on the last-gen Ryzen 7 5800X3D with the same core count, but compared with similar chips at the same price, it's markedly off the pace.

That's where Intel's top Core i9, Core i7, and Core i5 CPUs will make the cache-heavy AMD chip look positively laggardly. If you're after an all-rounder, a processor that's equally adept at multi-threaded task loads as it is with gaming, then move along; the 7800X3D isn't that versatile.

It's also the most energy efficient gaming CPU around. You could almost feign green credentials, building your system around the 7800X3D. The fact that it's significantly lower power, and more efficient in terms of frames per watt than even Intel's Core i5 13400F, is impressive.

It feels like AMD has saved the best for last, delivering us a chip purely dedicated to PC gaming that can match—sometimes beat—any other processor. If you want to do anything else with your PC then there are better options, but for pure gaming power and supreme efficiency, the Ryzen 7 7800X3D is a fantastic CPU. **–DAVE JAMES**

VERDICT

9

AMD Ryzen 7 7800X3D

+ BLAZING Top gaming performance; Super efficient; Cool running.

− BLASÉ High price compared with an i5 13600K/F; Comparatively weak outside of gaming.

$450, www.amd.com

BENCHMARKS

	Ryzen 7 7800X3D	Ryzen 9 7950X3D	Core i9 13900K
3D Mark Time Spy (1440p) (Overall Score)	16,573	17,265	**17,599**
Cinebench R23 Single Core (Score)	1,795	2,031	**2,201**
Cinebench R23 Multi Core (Score)	17,950	35,715	**38,610**
F1 2021 (fps)	**220**	218	192
Far Cry 6 (fps)	178	**183**	175
Metro Exodus (fps)	**134**	**134**	**134**
Shadow of the Tomb Raider (fps)	**223**	221	214
Total War: Three Kingdoms (fps)	**217**	**217**	214
Gaming Performance Per Watt (Far Cry 6) (fps per Watt)	**3.7**	2.86	1.86

Best scores are in bold. Our test bench consists of an Nvidia RTX 3080 10GB and 2TB Corsair MP600 Pro XT/1TB WD Black SN850 SSDs. The AMD bench used an ASRock X670E Taichi motherboard and G.Skill Trident Z5 Neo DDR5-6000 CL30 2x 16GB RAM, while the Intel bench used an Asus ROG Z690 Hero motherboard and G.Skill Trident Z5 RGB DDR5-5600 CL36 2x 16GB RAM. All tests were done at 1080p resolution at highest or ultra settings unless otherwise stated.

SPECIFICATIONS

Architecture	AMD Zen 4
Socket	AMD AM5
Lithography	5nm CCD | 6nm IOD
Cores	8
Threads	16
Base clock	4.2GHz
Boost clock	5GHz
L2 cache	8MB
L3 cache	96MB (inc. 64MB 3D V-Cache)
TDP	120W

Lenovo ThinkPad X13s

A glimpse of the Arm-powered future of the PC

ONE DAY, X86 PROCESSORS in PCs will be entirely replaced by Arm chips. That's the widespread assumption—just don't expect us to tell you if it will actually happen or when. What we can say for sure, however, is that if future PCs do end up being Arm-powered, then the Lenovo ThinkPad X13s will retrospectively be seen as a harbinger of things to come.

This slick little 13-inch laptop rocks a Qualcomm Snapdragon 8cx Gen 3 chip, a pure Arm-powered processor. If you're not familiar with it—and why should you be?—it runs four performance-spec Arm Cortex-X1 cores and another four Cortex-A78 efficiency cores.

You also get an Adreno 690 GPU, and in this particular configuration, 16GB of RAM and a 256GB SSD. It's all housed in a super high-quality 13-inch chassis, the form factor dictated by a 1,920 by 1,200 pixel IPS panel. It's a super-thin design, so the ports are limited to a pair of USB-C sockets, plus headphones and a SIM slot for 5G connectivity.

Physically, it's a very nice bit of engineering, but how does that Arm stuff even work with Windows? Well, Microsoft does an Arm-compatible build of Windows 11 complete with a compatibility layer for running x86 software. In theory, it's all totally seamless. You install a legacy x86 app just like you would a native Arm app, and it just works.

In practice, it's hit and miss, as some apps fail during the install process. Of those that work, they generally run smoothly, but at a performance cost. A good example is the Chrome browser. There's no native Arm Windows version available, so you have to install the x86 build. It seems to work fine at first—load up, say, a 4K YouTube video, and it plays without a glitch. But if you pull up task manager and have a look at the CPU load being generated, it looks a little ugly.

Chrome running a 4K video soaks up around 25 percent of the CPU's resources. But if you play the same video in Edge, which Microsoft has recompiled for Arm, the CPU load is only 5 percent. Put simply, your battery life running Chrome is going to take a major hit. That's a pity, because battery life is probably this laptop's main selling point. We managed just over 19 hours of battery life with Wi-Fi enabled and playing 1080p video via the native Arm Windows media app. That's proper all-day stuff—you might even manage a couple of days.

As for performance, it's difficult to make direct comparisons. Many of our benchmarks apps wouldn't install, but the 2,345 points the X13s returns in Cinebanch R23, for instance, is pretty feeble. It's slightly more than half of what you could expect from something like a U Series Intel Core i5 processor.

It's also less than one third of the performance of the M2 chip in Apple's MacBook Air, which is also an Arm processor. Ouch. If you factor in that the screen is merely okay (we recommend going for the optional 400 nit panel, as the 300 nit standard screen isn't bright enough), and that the $1,376 price as tested is hardly a bargain, then we can only conclude that if the Arm revolution is heading for the PC, you might want to wait a little longer to jump onboard.

The reality is that compatibility with x86 Windows software is patchy, so you wouldn't buy this for legacy apps; just the battery life. But to be frank, if you want an Arm laptop for that reason, Apple's MacBook looks better, lasts as long, has much better sound quality, a superior screen, and comparable build quality. It's not a Windows laptop, of course, but then nor is the ThinkPad X13s when you get right down to it. **–JEREMY LAIRD**

VERDICT

6

Lenovo ThinkPad X13s

+ ARMED TO THE TEETH Epic battery life; Fantastic build quality.

− TOTALLY DIS-ARMING x86 support is patchy; Outright performance is weak.

$1,376, www.lenovo.com

SPECIFICATIONS

Screen	13.3-inch, 1920x1200, IPS
CPU	Qualcomm Snapdragon 8cx Gen 3
RAM	16GB
Storage	256GB
Wireless	Wi-Fi 6E, Bluetooth 5.1, 5G modem
Ports	2x USB-C, headphone
Battery	49.5Whr
Dimensions	0.53 x 11.76 x 8.13 inches
Weight	2.3lbs

©UNSPLASH

Lenovo's beautifully built Arm laptop has epic battery life.

Pixio PXC277 Advanced

A high-refresh 1440p panel for relative pennies

IT'S VERY EASY these days to obsess over high graphics card prices and forget the fact that most PC components have trended back to historical norms—you know, norms that say tech gets not just better, but cheaper over time.

For proof, look no further than the Pixio PXC277 Advanced. It's a 27-inch, 165Hz, 1440p gaming panel, and it's yours for just $240. That's a lot cheaper than you could have got a similarly specified monitor just a few years ago, and that's just how things should be.

We haven't seen a Pixio monitor first hand before. It's a lesser brand and with that comes unclear expectations. Can it really be any good for this price? Actually, yes it can. The Pixio PXC277 Advanced is the real deal. There is nothing significantly wrong with this monitor; it does nearly everything pretty well. It's not perfect, of course, not for $240, but there's absolutely nothing sketchy or even close to be obviously broken.

Beyond the headline specs, you admittedly don't get a lot of extras. There's no USB-C connectivity, the stand only has tilt adjustment—you get the idea. But equally, the build quality is reasonable, and the styling is decently crisp and presentable. The Pixio does not scream "cheap option" by any measure.

Likewise, while there is token HDR support, there's no local dimming. Arguably more critical is the 250 nit brightness rating. On paper, that's low by today's standards. The other theoretical worry is the use of VA panel tech. Sure, you get increased contrast versus IPS panels as a consequence, but the concern is compromised pixel response compared to the fastest IPS panels.

You needn't worry. The Pixio PXC277 Advanced isn't as quick as the best IPS gaming monitors, but there's none of the nasty blurring and smearing you can get on really bad VA monitors. It's decently quick. More generally, the panel's calibration is surprisingly good. Genuinely, there are no horrors, backlight blotchiness, or unwanted sharpening filters. Instead, the color balance is well judged and the VA-enabled contrast actually beats any IPS monitor by a mile.

That contrast also helps with the panel's lack of outright punch. Okay, it looks a bit flat compared to a mini-LED panel with a 1000 nit backlight, but it's vibrant enough, especially for the money. If you factor in the zippy 165Hz refresh and low latency, plus the nice, crisp visuals thanks to the 2,560 by 1,440 pixel native resolution, the result is frankly a far better gaming experience than you have any right to expect for under $250.

Unsurprisingly, the on-paper HDR support is borderline non-existent in practice. Yes, the Pixio will render colors in HDR content correctly, but a high dynamic range experience it certainly is not. The monitor also isn't well calibrated to display SDR content in HDR mode. The net result of this is that you'd rarely want to switch over to HDR mode. Just think of it as purely an SDR monitor, which is great at this modest price point.

The final doubt is whether this will hold up long term. Whoever put it together knew what they were doing, and as far as it is possible to judge the quality of the components and build, there's nothing that implies corners have been cut, so we'll give Pixio the benefit of the doubt.

As an all-round display for work as well as play, this really is a polished package. Moreover, it's nice to know that you're not limited to 1080p options at this price point. What with the new breed of OLED monitors, people are currently paying $1,000 for monitors with exactly the same panel size and resolution. Make no mistake, they're not getting four times the monitor. **–JEREMY LAIRD**

VERDICT
8

Pixio PXC277 Advanced

⊞ **BY GRABTHAR'S HAMMER...** Excellent specs; Decent image quality; Low price.

⊟ **WHAT'S THE SAVINGS?** Not terribly bright; Very limited HDR support.

$240, www.pixio.com

SPECIFICATIONS

Panel size	27-inch
Panel type	VA
Resolution	2560 x 1440
Refresh rate	165Hz
Brightness	250nits
Contrast	4000:1
Inputs	2x DisplayPort 1.2, 1x HDMI 2.0

© UNSPLASH

It's from a lesser brand, but this Pixio panel is surprisingly polished.

Nvidia RTX 4070

An RTX 3080 with benefits

THE NVIDIA RTX 4070 is a $100 cheaper RTX 3080. That's the easiest, but probably also the most facile, way to describe the green team's new graphics card. This is the fourth entry in the notoriously expensive Ada generation of GPUs, and in standard metrics performs as well as the fourth-tier card from the Ampere lineup. On the face of it, it's just a cheaper chip.

But it's not just that. This smart new Nvidia card is also an RTX 3080 with benefits. This is the first of the Ada graphics cards to utilize the same GPU as the previous release, just with a little of the good stuff cut back to create a more affordable offering. That also means Nvidia is able to do something useful with any chip that fails to make the grade as an RTX 4070 Ti, which otherwise uses the full AD104 die, or a mobile RTX 4080.

Though the RTX 4070 is cheaper than an RTX 3080, with its $599 sticker price, Nvidia is once more raising the cost of seemingly equivalent classes of card. The RTX 3070 of the last gen came in at $499, which means this new GPU is effectively replacing the similarly $599 RTX 3070 Ti. This almost inevitable shift in the price tiers takes a touch of the shine of the RTX 4070, but there are many other reasons why I'm still a fan of this new card.

Let's start with looks. It's not some monstrous hulk of PCIe socket-rending GPU; it's a modest card the size of its RTX 3070 forebear. That makes it a rather cute-looking thing. The size of the card hints at the efficiency of the 4nm Ada GPU quietly thrumming away inside of it. If you want a powerful but low-power card, the RTX 4070 fits the bill. This will no doubt make it the darling of the small form factor PC brigade, and deservedly so.

That's certainly one of the benefits I was alluding to earlier, but the key one is the fact that the Ada card has access to DLSS 3.0 and Frame Generation. When that comes into play, it's a game changer, especially for titles that would otherwise struggle at ray-traced 4K settings. The obvious drawback is that Frame Gen is not widely available. Even so, getting a $100 discount on a cooler, quieter, and far more efficient RTX 3080 has got to feel like a win when you've got that extra potential performance bump.

EXTRA EFFICIENCY

The actual specs look almost identical to the RTX 3070. The RTX 4070 has the same 5,888 CUDA cores, the same 184 Tensor Cores, and 46 RT cores as its predecessor. The only real difference in the core config is the fact that there are notably fewer render output units (ROPs) in the newer card.

But this isn't a straight idiomatic fruit versus idiomatic fruit comparison here; both the new Tensor and Ray Tracing Cores are a generation further on, and the whole thing is built on TSMC's advanced 4nm node. That means you get a lot more efficiency out of the chip, and can clock the hell out of it, too.

With more and more 240Hz+ gaming monitors rocking 1440p resolutions now, it's here that the RTX 4070 is looking really tasty. It's also here that we do see a few tangible improvements over the standard gaming performance of an RTX 3080, too.

The 4nm Ada architecture is supremely efficient and impressively light on power demands, even when it's topping 2.6GHz clock speeds. With an average gaming power draw of just 197W, that's more than 100W less than an RTX 3080 running at full chat, and around 90W less than an RTX 3070 Ti, too.

On the whole, that extra 20–30 percent extra standard gaming performance you can get over the RTX 3070 Ti with this card makes it look like a really solid gen-on-gen upgrade, if not exactly spectacular. Again though, it's DLSS et al that makes the newer card far more than the sum of its rasterized performance. **–DAVE JAMES**

VERDICT

8

Nvidia RTX 4070

⊕ **GAMING POWERHOUSE** Cheaper than an RTX 3080; Frame generation; Cool, quiet, and efficient.

⊖ **GAMING THE SYSTEM** Frame Generation isn't ubiquitous.

$599, www.nvidia.com

BENCHMARKS

	RTX 4070	RTX 4070Ti	RTX 3080 10GB
Cyberpunk 2077 RTX (fps)	39	**50**	37
F1 22 RTX (fps)	71	**93**	63
Far Cry 6 RTX (fps)	110	**117**	94
Metro Exodus Enhanced (fps)	87	**109**	83
Warhammer Total War III (fps)	90	**111**	90
Red Dead Redemption 2 (Vulkan) (fps)	103	**125**	103

Best scores are in bold. Our test bench consists of an Intel Core i9 12900K, Asus ROG Z690 Maximus Hero, 32GB G.Skill Trident Z5 RGB DDR5-5600 RAM, 1TB WD Black SN850/4TB Sabrent Rocket 4Q SSDs, and Windows 11 22H2. All tests were done at 1440p resolution at highest or ultra settings.

SPECIFICATIONS

GPU	AD104
Architecture	Ada Lovelace
Lithography	TSMC 4N
CUDA cores	5,888
SMs	46
RT Cores	46
Tensor Cores	184
ROPs	64
L2 cache	36,864 KB
Boost clock	2,475MHz
Memory	12GB GDDR6X
Memory interface	192-bit
Memory bandwidth	504 GB/s
Die size	294.5mm^2
Transistors	35.8B
TGP	200W

The real difference-maker is Nvidia's Frame Generation tech.

Intel NUC 13 Pro i7-1360P kit

Pocket-sized 13th Gen Intel i7 power for the enthusiast?

THE INTEL NUC has been around for about a decade, making it as old as the PS4 and Xbox One. Yet, this tiny form factor PC still continues to impress us, with new variants released annually. With Intel's 13th generation CPU now available, a NUC housing these chips was bound to happen, and we've gotten our hands on a pre-production unit of the Intel NUC 13 Pro (codenamed Arena Canyon). We've featured a similar NUC-based product, the Geekom Mini IT8, before, but that had an 8th gen processor, so this NUC 13 Pro should be a big step up. Is it the right mini PC for you?

Design-wise, not much has changed since the last two iterations of the Pro models. Our NUC is the slim "K" chassis, which is 4.6 x 4.6 x 1.4 inches in size. You can also go for a slightly larger "H" model, which is taller at 2.1 inches. The K chassis is a super slim and discrete model. It has a plastic housing, but doesn't feel cheap. Around the sides are metal vents to help with the cooling for this NUC, and underneath are grippy rubber feet to stop it from sliding around on your desk.

It's a minimalist black box that is Vesa mount compatible, so you can stick it on the back of a monitor thanks to the supplied screws. It could also hide under a desk, or be wall-mounted—the possibilities are endless, making it perfect for a minimalist setup. You'd think that at this size there'd be a compromise when it comes to ports, but you'd be mistaken. Along the front, you get two USB Type-A ports and a 3.5mm audio jack next to the power button. Turn this thing around, and you're greeted by two more USB Type-A ports, two Thunderbolt 4 USB Type-C ports, two HDMI ports, and a 2.5 Gbps ethernet port.

You can purchase these Intel NUC 13 Pros in multiple configurations or as a barebones kit in which you can add your own internals. Memory-wise, you can add up to 64GB of SODIMM RAM (we have 32GB of DDR4 @3200MHz). In terms of storage, our model (specced by Intel) comes with a Samsung 512GB Gen 4 NVMe SSD. That's plenty for a work-based system this tiny. This isn't for gaming, so most of the storage will be used for files and system data. If necessary, storage can be upgraded too. Opening it up is a breeze—you gain access to the internals via four Philips captive screws.

That leads us nicely to the main component of this NUC Pro, the Intel Core i7-1360P processor. It features 18MB of cache, a max turbo frequency speed of up to 5.0GHz, 16 threads, and 12 cores. As this CPU has Intel's hybrid architecture, it splits these cores up into four performance and eight efficiency ones. Seeing as this will be a more task-based system used for everyday work and some creativity-based operations, the efficiency cores are important to keep the background tasks running efficiently. Performance was admirable on this little device, and with multi-core Cinebench Results of 12,214, it's a strong CPU.

The argument here would be that for the money, you should get a desktop PC, seeing as it offers more value for money. But what the NUC is pushing is a tiny form factor and minimalist alternative. Sure, a laptop/ultrabook provides more of those credentials than a desktop, but the NUC Pro has more ports and is easier to upgrade. If you're tight for space or need to fill an office with PCs, but want to keep a seamless setup for everyone, then the Intel NUC Pro models are a great package with plenty of performance. You can't game on ultra settings, but when we did 1080p tests running at low/medium settings, it's possible to get around 40+ fps.

Pricing is where we have our issues—these kits start from $850 upward, and if you get the bare bones, you'll need to provide your own RAM and SSD. On the flipside, you are getting the Intel Core i7-1360P, which has a retail price of $480 on its own. In the grand scheme of things, for a powerful mini PC, with a very quirky form factor and plenty of ports, so it's not a bad package at all. **–SAM LEWIS**

VERDICT

8

Intel NUC 13 Pro i7-1360P Kit

+ MINI AND MIGHTY Speedy processor; Plenty of ports; Potential to upgrade.

− PRICE WOES Not really for gaming; Similarly priced more powerful laptops available.

$850+, www.intel.com

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	1,865	1,910 (2%)
Cinebench R23 Multi-Core (Index)	13,186	12,214 (-7%)
CrystalDisk QD32 Sequential Read (MB/s)	7,072	6,841 (-3%)
CrystalDisk QD32 Sequential Write (MB/s)	5,228	5,088 (-3%)
3DMark Fire Strike (Index)	2,420	5,264 (118%)
Cyberpunk 2077 (fps)	13	14 (8%)
Total War: Three Kingdoms (fps)	12	22 (83%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our 1080p zero-point consists of teenage engineering computer-1 build from our September 2022 issue. It includes an Intel Core i5-12600K, an ASRock B660M-ITX/AC, 32GB of PNY XLR8 DDR4-3200, and a 1TB Samsung 980 Pro PCIe 4.0 NVMe SSD. All games tested at 1080p 'Ultra' graphics presets with DLSS/FSR and V-sync turned off. XMP/AMP for RAM speed turned on in all tests. No manual CPU overclocking.

SPECIFICATIONS

CPU	Intel Core i7-1360P
GPU	Intel Iris Xe Graphics (integrated)
Memory	32GB DDR4 @3200 MHz SODIMM
Memory	Samsung 512GB M.2 Gen 4 NVMe SSD
Ports	3x USB Type-A 3.2, 1x USB Type-A 2.0, 2x Type-C Thunderbolt 4, 2 x HDMI, 1 x 2.5Gbps Ethernet Intel i226, 3.5mm audio jack
Connectivity	Bluetooth 5.3, Intel Wi-Fi 6E
Dimensions	4.6 x 4.6 x 1.4 inches

For such a small package, a lot is packed in.

AOC's latest 24-inch gaming monitor is all about speed.

AOC Gaming 24G2SP

High-refresh, low-latency gaming on a budget

CARVING OUT A NICHE in the busy monitor market isn't easy, but AOC has managed it better than most. A decade ago, it was a maker of utterly anonymous low-cost flat screens for office workers. Now, it's one of the most prolific gaming monitor brands in the business with screens to suit all budgets.

In that context, the new AOC Gaming 24G2SP combines AOC's hard-won gaming rep with its origins as a value-orientated outfit. This is a 24-inch 1080p panel, which is pretty modest by today's standards. But it offers a fair few gaming niceties, including 165Hz refresh, 1ms claimed response, and variable refresh rate.

As is the norm for gaming monitors, even at this end of the market, AOC has gone for IPS panel tech. That helps with achieving the low response times, but also bodes well for color accuracy. It's less of an advantage for contrast performance and black levels. Indeed, AOC doesn't bother with any HDR pretence—there's not even token HDR400 or HDR10 support. This is purely an SDR panel.

To be frank, we're fine with that. Very few so-called HDR panels based on LCD technology deliver something approaching true HDR experience. Those that do, namely mini-LED monitors with full array local dimming, not only cost a fortune, they come with all kinds of compromises that undermine the overall image quality.

© UNSPLASH

Anyway, AOC rates the AOC Gaming 24G2SP at 300 nits for brightness, which is reasonable for an SDR monitor, while contrast is rated at 1,000:1, which again is par for the IPS course. As for inputs, you get a single DisplayPort 1.2 socket and a pair of HDMI 1.4 ports. The latter two only run to 144Hz refresh rather than 165Hz, which is limited to the DisplayPort connection.

On the ergonomics side, the stand adjusts for height, tilt, and swivel. This is an all-plastic affair, though reasonably well built given the modest price. Our only quibble with the design is that the icons molded into the chin that denote the OSD control buttons are pretty much invisible, making settings changes more of a pain than they really ought to be.

Speaking of the OSD, AOC's layout is fairly comprehensive, if dated. Perhaps the most significant option involves the three levels of pixel overdrive. For once, the fastest setting is actually usable, delivering nippy pixel response with barely, if any, visible overshoot.

Running at the full 165Hz refresh, latency is very well suppressed, too. For overall speed, then, this is an extremely responsive display. It's probably not quite pro-level esports material, but for most, it will allow competitive performance in the usual online shooters.

It serves up a decent experience in other game types thanks to punchy image quality for an SDR display and vibrant but not oversaturated colors. As a 1080p monitor, the image detail can't compete with 1440p, let alone 4K monitors. But then you've got half a chance of achieving nice smooth frame rates with a mid-range graphics card.

Where 1080p is a little harder to rationalize is on the Windows desktop. Here in 2023, 1,920 by 1,080 pixels feels quite constraining, especially when you can have the full 4K experience for not much more money. Of course, at anything approaching this price, a 4K monitor will be a basic 60Hz affair, but the 1080p resolution does push the AOC Gaming 24G2SPU into dedicated gaming territory.

If you're looking for something super speedy but still affordable, and very much predominantly if not exclusively for gaming, then the AOC Gaming 24G2SP is a great choice. But for an all-round compromise between gaming and other computing duties, we'd be inclined to up the budget just a bit for something like the Pixio PXC277 Advanced, also reviewed this month, which ups the ante to 27 inches and 1440p. **–JEREMY LAIRD**

VERDICT

8

AOC Gaming 24G2SP

+ **SPEED DEMON** Zippy response; Low latency; Nicely calibrated.

− **DEVIL'S ADVOCATE** No HDR support; "Only" 1080p.

$214, www.aoc.com

SPECIFICATIONS

Panel size	24-inch
Panel type	IPS
Resolution	1920 x 1080
Refresh rate	165Hz
Brightness	300nits
Contrast	1000:1
Inputs	1x DisplayPort 1.2, 2x HDMI 1.4

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HyperX Pulsefire Haste 2 Wireless

A lightweight wireless gaming mouse at a very competitive price

SPEED IS THE NAME of the game when it comes to the HyperX Pulsefire Haste 2 Wireless. In fact, it's actually in the name itself, so that's convenient. Any competitive gamer will tell you that if you want to achieve high K/D/As, you'll need a speedy (and accurate) gaming mouse to keep up your reflexes. The lightweight Haste 2 wireless has a lot going for it; best of all, it's only $90. It's not perfect, but its speed and price are enough to put up with some rough edges.

The wireless (and wired) Haste 2 comes standard with that fancy new HyperX 26K sensor with a tracking speed of 650 IPS—good for twitch shooters or games that have a lot of frantic movements that still require you to be accurate as well, like *Valorant* or, I can't believe I'm saying this, *Counter-Strike 2*.

The six-button mouse has 2.4GHz wireless and Bluetooth connections along a near-six-foot paracord cable for wired gameplay when recharging, which shouldn't be often, considering its fairly long battery life of 100 hours. If you aren't a wireless mouse user, the wired Haste 2 retails for $60; however, you won't see much perceptible difference in speed or accuracy where the mouse is plugged in versus when it's not.

Personally, I found Haste 2 especially useful in a game like *Warhammer 40K Dark Tide*, where legions of relentless *Warhammer* creepies are trying to kill you. The Haste 2 allowed me to keep up with the action that happened all around me. It was nice to pick off quickly infected Poxwalkers from all directions, nailing crucial headshots or doing some good old-fashioned spraying and praying.

It also helps that this wireless mouse is only 61g, which is pretty light, though if you need to go even lighter, the wired Haste 2 sits at only 53g. A heavy mouse could lead to hand strains in the long term, so you want a light gaming mouse for ergonomic reasons alone. For gaming, though, less weight means faster mouse swipes.

MAKE HASTE

The one downside I experienced while using it was that it felt slightly slick, especially when my right hand got clammy in a very intense closing stage of a match in *Fortnite*. Thankfully, the Haste 2 does come with some stick-on grips for the side and mouse buttons, which I found alleviated that problem and, quite frankly, felt great in my sweaty hand.

My issue is that the grip tape looks pretty ugly. I, of course, managed to put the grip tape on crooked on the right mouse button, which drove me nuts. Thankfully, after the third or fourth attempt, I applied it much straighter. I'd imagine it's less noticeable on the black version of the Haste 2, but the white one I have here looks pretty silly and takes away from the sleek design.

After using it as my primary gaming mouse for just over a week for work and play, I've drained down to about 65 percent of the battery so far. Chances are I could eke more time had I opted to turn off the RGB lighting. However, that doesn't affect the battery much, unlike the Glorious Model O 2 wireless, which completely wiped out the battery after two days when the RGB was turned on. To be fair, that mouse has more RGB zones, while the Haste 2 just has RGB LEDs on the wheel.

The HyperX Ngenuity app has always had some issues. It would crash on my Windows 11 PC almost half the time I used it. Also, the mouse only has one profile. Once I updated the mouse's firmware, I deleted the app for my sanity.

The HyperX Haste 2 is a solid budget wireless gaming mouse whose performance and accuracy can keep up with rodents double its price. However, it lacks some of the bells and whistles you might be used to. It's a concession you'll have to make for competitive gaming on a budget. **–JORGE JIMENEZ**

VERDICT
7

HyperX Pulsefire Haste 2 Wireless

⊞ **SPEEDSTER** Lightweight; Good battery life.

⊟ **SLOWPOKE** Ugly stick-on grips; Only one profile; Ngenuity app is a pain to use.

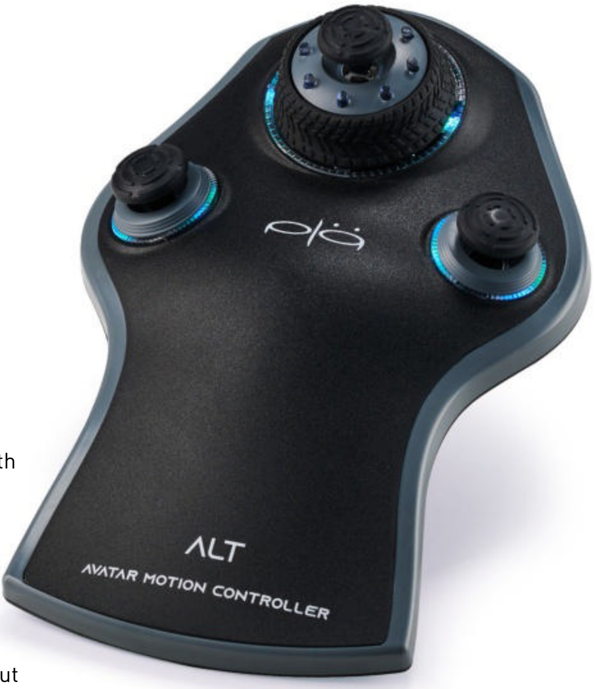
$90, www.hyperx.com

SPECIFICATIONS

Sensor	HyperX 26K Optical Sensor
Sensitivity	26,000 dpi
Polling rate	1,000Hz
Programmable buttons	6
Lighting	1 customizable RGB zone
Connection	2.4GHz (dongle), Bluetooth, USB
Weight	61g

PLA ALT Motion Controller

An unorthodox, unusual, and unique keyboard alternative? We're interested.



THE WORLD ISN'T SHORT of bizarre gaming controllers or 'intuitive' peripherals—just take a look back at the Sega Fishing Rod for the Dreamcast, the NES Power Glove, the Donkey Kong Jungle Beat bongos, or even the Tony Hawk Ride Skateboard. They will always hold a special place in our hearts, but trust us, the Sega Fishing Rod did us no favors when hopping into *Apex Legends*!

The faithful keyboard and mouse combination has stood the test of time, yet that might just be down to what we know best and not wanting to break the mold. PLA LABS is challenging this traditional gaming setup with the ALT Motion controller, which certainly looks like a distinctive peripheral.

At first glance, it's mouse-shaped and symmetrical, with an ambidextrous design. This controller is aimed to be used alone or alongside a mouse, so it should be a seamless addition to your existing setup, as it doesn't take up much desk real estate. Underneath are clear rubber feet that prevent it from sliding across your desk. The bottom end of the device features a wrist rest, which we have to say is rather comfy, so it's easy to find a suitable position for this. It bulges outwards, creating an ergonomic curve for your hand to sit on.

Quality-wise, and with the $299 price tag in mind, we aren't fully satisfied, as it does feel weak in some areas. We get that this is essentially a startup project that has been evolving since 2015, but at the price point, quality is what you expect. We must also mention Edward Larkin, who is leading PLA labs, was behind the invention of the mouse bungee in 1994, and formally worked for Razer, so he certainly knows a thing or two about peripherals.

Aesthetically, it features a matte black chassis, with gloss-gray accents that again should be a universal fit for most setups. If you need a bit of color, there are RGB ring lights around each of the analog sticks. Speaking of which, the one on the left and right are identical, with one at the center towards the top which is larger due to a rubberized control wheel. These thumbsticks have plenty of grip on them, thanks to the textured finish on each of the convex sticks. We say thumbsticks, but technically only one will be. The way we used this was left-handed with our thumb on the right stick, our middle finger controlling the center stick, and our pinky on the left stick. The fundamental issue with new controllers is the bedding-in process, and it wasn't the most natural feeling, but after a few hours, you start to pick up the pace and things become more intuitive.

CONFIGURE IT YOURSELF

Where the ALT Motion Controller really shines is its customizability. It's essentially a macro device, so you can map this to whatever you see fit. We loved using the wheel on, you guessed it, racing games in particular. Five tabs are at the top, including settings for profiles, lighting, programming, wheels, and macros. Within the wheel tab, you can map the left steering to A and the right to D, just as it is using typical WASD keyboard controls. You can map the analog sticks to specific keys within the macro settings, too—this creates many possibilities to control games exactly how you'd like. A device like this would be very well suited for emulation as well, as you can create separate profiles for different consoles. Going back to the software, although very easy to navigate and use, it is a bit of a disappointment for a $299 product. It leads us back to quality, and its design is rather lackluster here. It feels like a rushed application although fundamentally it gets the job done.

We had fun using this ALT Motion controller as a step away from a keyboard or standard gaming controller. It's best suited to FPS titles, and although it wasn't the easiest to pick up, we got there in the end. It certainly gives you a lot more flexibility and options, and hits the nail on the head when it comes to ergonomics. Our issues lay with the overall fit and finish, and software gripes. Unfortunately, at the moment, it's just not quite there for the $299 price tag.

The unit is currently available to pre-order, and if you're after a unique and intuitive way to play games, this could certainly be a good option if you're willing to overlook some of the issues we found. –**SAM LEWIS**

VERDICT
6

PLA ALT Motion Controller

+ **FPS WINGMAN** Comfortable ergonomic design; Grippy controls; Vast configurations; Helpful online video tutorials supplied.

− **FORCED NATURE** Pricey peripheral; Slightly cheap feeling; Poorly designed software; Niche uses.

$299.99, www.plalabs.com

SPECIFICATIONS

Compatibility	Windows 10+
Internals	Advanced Adruino-Based Micro Processor, neodymium magnetics (for torque steering).
In the box	6ft braided Micro USB cable, 4GB USB drive (video instructions, drivers, programming examples, warranty).
Connectivity	Micro USB

Razer BlackWidow V4 Pro

So I heard you like macros…

RAZER IS A heavyweight of the keyboard world, and its BlackWidow range has just been updated with some fancy new features and a price tag to match. Is it worth your cash?

Compared to the BlackWidow V3 Pro, the latest update tweaks the media controls, repositions the control dial, and adds a fistful of macro buttons. You also get RGB illumination underneath both the keyboard and the included wrist rest, because apparently BlackWidow keyboards weren't shiny enough already.

Speaking of RGB, this wouldn't be a Razer product if it didn't offer a smorgasbord of lighting effects for your keys too, and there are 11 light show presets to choose from in the Synapse app. What's that? Presets are for noobs? Well, you're in luck, because you can create your own RGB effects in obsessive detail with Razer's Chroma Studio tool, helping you finally put that pricey art degree to good use.

There are only two switch options: Razer's clicky greens or linear yellows. Our review unit came with yellows, and while they weren't awful, they felt a little heavy in use. Whichever you pick, they come with pre-lubed stabilizers and two layers of dampening foam, although there's no hot swap option.

As you'd expect from Razer, the plastic and aluminum construction exudes premium quality. Yet for such a chonker of a keyboard, it is impressively lightweight. We're not saying you'll be able to lift it with your pinky finger, but Razer has done a good job of keeping the weight down without compromising its integrity. It's matched by one of the softest, most beautifully comfortable wrist rests we've tried, and placing our tired limbs on its feathery surface never got old. It must be what God's pillows feel like.

CUSTOMIZATION GALORE

Where the BlackWidow V3 Pro had three media control buttons and a dial in the top-right, the V4 Pro ups that to four buttons and moves the dial to the top-left corner, replacing it with a volume roller. The roller is a welcome addition, and it's particularly handy for quick adjustments on the fly. The buttons are not backlit, though, which makes it very hard to see what each one actually does.

The dial, meanwhile, lets you cycle through a range of commands, from vertical scrolling to alt tabbing. These can be enabled or disabled from Synapse, and the RGB glow under the dial changes color depending on the function you've chosen. It's a clever, well-thought-out feature. The only issue is the dial is right on the edge of the board, exactly where your muscle memory has trained you to think the Esc key is—blindly pressing the wrong key is a frequent problem.

Below the dial are five customizable macro keys with more options than a New York City day trader. They're complemented by another three macro buttons just off the left-hand edge of the chassis. While those three off-edge keys are slim and not the easiest to find, having eight dedicated macro buttons will be a boon for shortcut wizards.

It's not just the macro keys that are customizable—you can remap every button and dial, from the volume roller to Y. While you might not feel the need to alter every single key on the device, that level of flexibility is appreciated.

Disappointingly, the V4 Pro drops the wireless support of its predecessor, so you can only connect to one device using the included USB-C to USB-A cable. You'll also need a second cable if you want to use the USB-A passthrough port.

Still, there's no doubt that the BlackWidow V4 Pro is stacked to the gills with features. Its handful of slip-ups stop it being an instant buy (as does the hefty price), but if you're after a premium keyboard built for macro lovers, it should be on your radar. **–ALEX BLAKE**

VERDICT
8

Razer BlackWidow V4 Pro

➕ **SILK** Stuffed with clever extras; super-comfy wrist rest.

➖ **VENOM** Sub-par switch choice; drops the wireless support.

$229.99, razer.com

SPECIFICATIONS

Switch type	Razer Green (clicky) or Razer Yellow (linear), box-style cross stem, non-hot-swappable
Backlight	RGB
Polling rate	Up to 8,000Hz
Keycaps	Doubleshot ABS
Onboard memory	Up to five profiles
Connector	USB-C to USB-A
USB passthrough	USB 2.0
Dimensions (hwd)	42 x 466 x 224mm (including wrist rest)
Weight	1146g (without wrist rest), 1548g (with wrist rest)

Lead character Cal Kestis grapples with the futility of rebellion in *Survivor*.

ACTION-ADVENTURE GAME

Star Wars Jedi: Survivor

The best thing to happen to Star Wars in years

AT A GLANCE, *Jedi: Survivor* falls on the pulpy, safer side of *Star Wars*—the gifted Jedi with untapped potential, a faithful droid companion, and a swashbuckling crew certainly paint that picture, but there's more to lead character Cal Kestis. *Jedi: Survivor* doesn't shy away from the darkest chapter of *Star Wars* history, findaas humor in an unfair world, and sometimes succumbs to helplessness.

It's not a story about fighting the Empire as much as coping with its dominance, grappling with the futility of rebellion, and questioning what's left to fight for. The modern *Star Wars* media that this feels closest to is *Andor*, though it's not as ambitious in its storytelling or as cynical. Unfortunately, those themes take a backseat through the middle of the story while Cal Kestis and crew entertain the deranged tantrums of a skin-deep evil guy with a red lightsaber, reminding us that this is still *Uncharted* in space.

But man, is it damn good space *Uncharted*. Better, in fact, because *Jedi: Survivor* breaks free of the Naughty Dog trends 2019's *Fallen Order* chased. Yes, Cal climbs up crumbling buildings and swings on ropes, but he also double jumps, air dashes, wallruns, and grapple hooks all over the place. There's an almost equal ratio of combat to platforming, and both things are fun this time around.

Jedi: Survivor revisits an era when third-person action games were designed like jungle gyms—bottomless death pits flanked by a wall you can climb, platforms that move for no reason, floating balloons that slingshot you across the sky. Respawn has resurrected the big-budget 3D platformer, and it's glorious.

Much of *Jedi: Survivor*'s platformer spirit is felt in its hub world of Koboh, a frontier planet in the midst of a turf war between stormtroopers and raiders wielding reprogramed prequel droids. You might be surprised to find out that half (if not more) of the game takes place on Koboh, but that's because it's packing multiple full-sized levels, side quests, secret areas, puzzle rooms, and optional boss battles. It's deep, wide, and technically an open world, but not a boundless sandbox. It's more like a collection of linear levels connected to a central area like spokes on a wheel—a PS2-style platformer without the loading screens, essentially.

The only thing *Jedi: Survivor*'s missing are trails of floating gems or coins to draw my eye to optional areas. Instead, Respawn has made a dozen or so sidequests and bounty hunts that take you to less-explored corners of the map. Sometimes the quests come with a bit of story setup from a local, but they're often just a tip to go cave diving for treasure or a heads up about a particularly nasty droid. Rewards are usually underwhelming perks like "more block meter", a new pair of pants, or tiny health bar upgrades, but the mini dungeons and environmental puzzles are fun enough that I sought them out constantly.

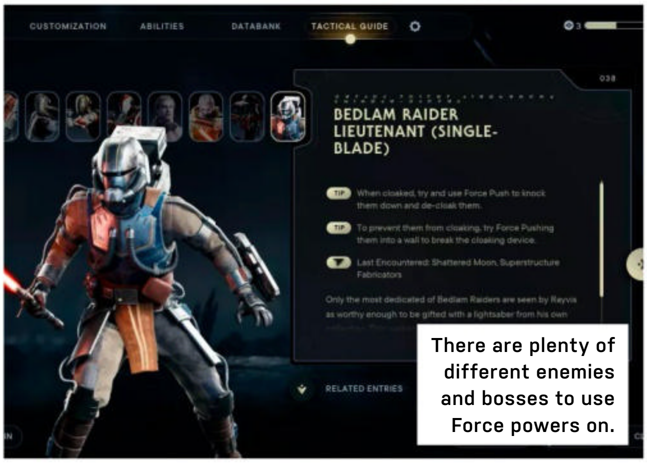
Cal's lightsaber, blaster, and BD-1 droid can be customized with dozens of different parts and materials. The details are immaculate, and I'm sure a bigger *Star Wars* fan than me will find a specific middle chunk lightsaber piece and recognize an obscure reference, but I found a setup I liked early on and rarely changed it, which speaks to a general loot problem in *Jedi: Survivor*. You never know if the next chest Cal opens is holding a permanant upgrade, new ears for BD-1, or a handlebar mustache.

JEDI ACADEMY

The one aspect of *Jedi: Survivor* that hasn't been reimagined is combat. It has been enhanced, though, and is even better now that droids are in the mix. Cal has

The game doesn't shy away from darkness, but also finds humor in an unfair world.

The game's combat is as exciting as ever, with fun new stances and sabre options.



BEDLAM RAIDER LIEUTENANT (SINGLE-BLADE)

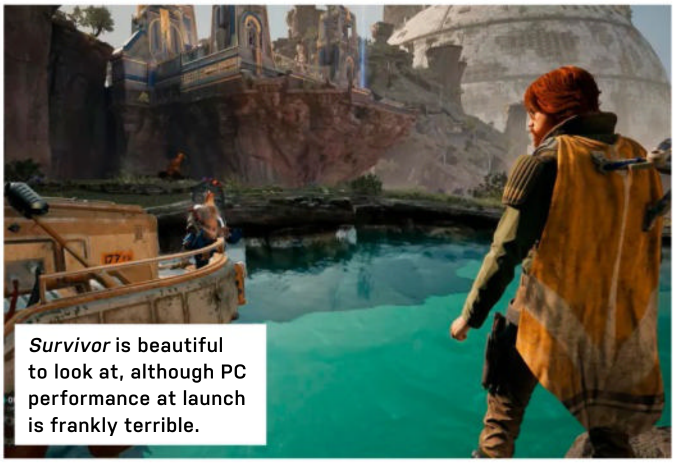
TIP When cloaked, try and use Force Push to knock them down and de-cloak them.

TIP To prevent them from cloaking, try Force Pushing them into a wall to break the cloaking device.

Last Encountered: Shattered Moon, Superstructure Fabricators

Only the most dedicated of Bedlam Raiders are seen by Rayvis as worthy enough to be gifted with a lightsaber from his own

There are plenty of different enemies and bosses to use Force powers on.


Survivor is beautiful to look at, although PC performance at launch is frankly terrible.

© RESPAWN ENTERTAINMENT

gotten a lot more lethal with a saber in the five year time skip—limbs are chopped off from heavy attacks (troopers and droids alike), giant bugs can be entirely bisected, and sometimes Cal will unholster his blaster for a finishing execution that I assume he learned watching *John Wick*.

Oh right, Cal has a blaster now. It's one of the two saber stances new to *Jedi: Survivor* for a total of five: single saber, double-sided saber, dual saber, blaster, and crossguard. I'm impressed at how Respawn has managed to make what is essentially the same saber feel like five distinct weapons—each stance has a unique moveset, its own upgrade tree and inherent tradeoffs. The double-sided saber's long reach, for instance, makes it the undisputed king of crowd control but doesn't hit as hard. Dual sabers deal a lot of damage quickly, but you have to commit to long combos that expose Cal's flanks. Crossguard stance (the Kylo Ren one) is basically a medieval claymore: devastating chops and cleaves that take a long wind up to connect.

Jedi: Survivor's combat clicked way better with me than *Fallen Order*'s. Stances are part of it, and having easily three times more types of enemies is nice, but honestly, I like that it's easier. I hardly ever lost to a normal group of enemies, and when I did, those shortcuts got me back to the action in no time. Health stims are easier to find, and several are doled out by simply progressing the story, which actually balanced out nicely. On default difficulty, I usually had enough health stims to squeak through a tough fight.

ROUGH GO

The only thing that threatened to ruin my good time were the constant performance issues with the PC version. Even with Nvidia's latest driver specifically optimized for the game, the framerate regularly slowed to a crawl at very annoying moments. Stepping through doors sometimes triggers double-digit framerate drops for ten seconds or more. Cutscenes often plummet to 15-20 fps, cut off or overlap dialogue, and usually don't recover until I get control back.

The worst slowdowns always seem to occur when the game's loading stuff in the background. Using the galaxy map on Cal's ship turned into a slideshow every single time, presumably because it's begun loading the planet I'm about to travel to. Performance in the most open parts of Koboh is pretty bad, too. On an RTX 2080 Super, i9-9900KS 4.00GHz, and 32GB RAM, I was lucky to squeeze a 35 fps average in the semi-open world. Isolated levels ran flawlessly at 80-90 fps, so there's clearly something up with the way Respawn is drawing big spaces. I briefly tried one other machine (RTX 3060, Ryzen 7 5700G, 16GB RAM) and had the same problems.

Unacceptable performance aside, I had a great time. *Jedi: Survivor* is a bigger and bolder game than its predecessor that prioritizes tight level design over scale—a rarity in an age of sprawling sandboxes. This is Respawn firing on all cylinders, having finally figured out what works in its weird soulslike adventure format.

–MORGAN PARK

VERDICT
7

Star Wars Jedi: Survivor

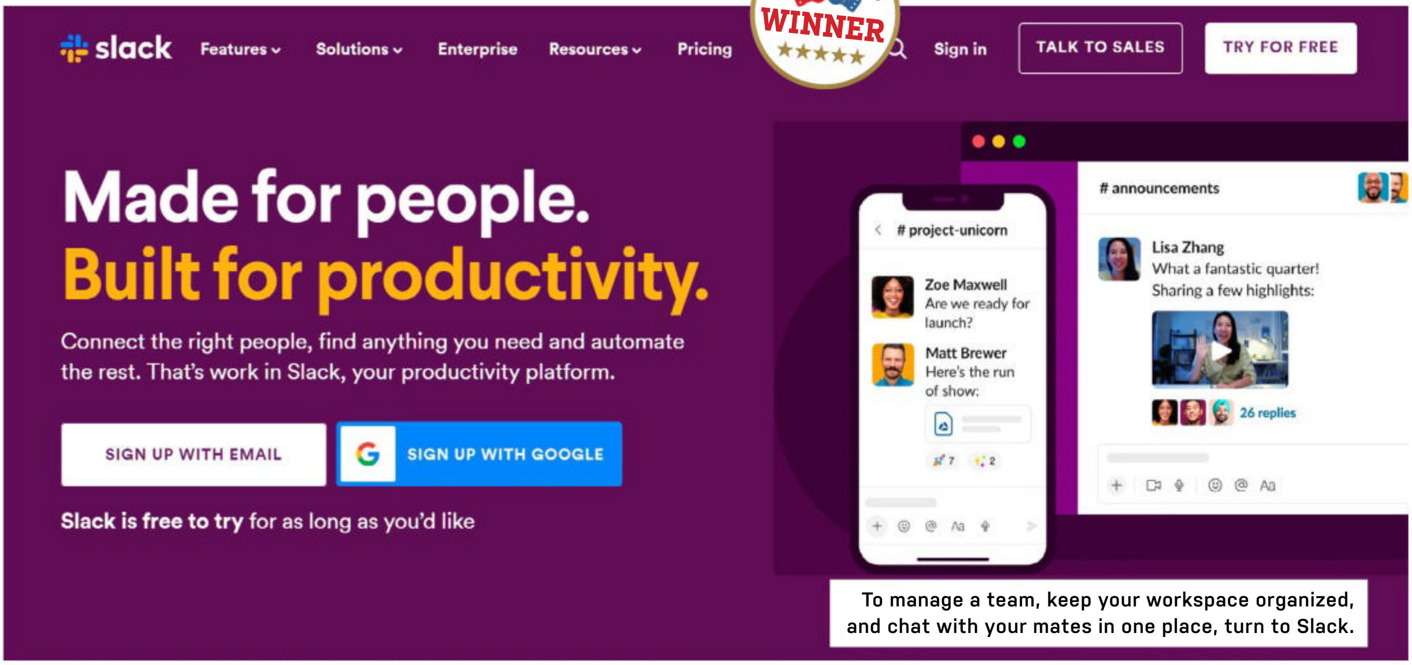
THE FORCE AWAKENS Brilliant combat; Engaging story; Loads to explore.

THE RISE OF SKYWALKER Catastrophic performance issues; Takes a while to get going.

RECOMMENDED SPECS CPU, Core i5-11600K/Ryzen 5 5600X. GPU, RTX 2070/RX 6700 XT. RAM, 16GB.

$69.99, www.ea.com/games/starwars, T-rated

HEAD TO HEAD WINNER ★★★★★



Made for people.
Built for productivity.

Connect the right people, find anything you need and automate the rest. That's work in Slack, your productivity platform.

Slack is free to try for as long as you'd like

Zoe Maxwell
Are we ready for launch?

Matt Brewer
Here's the run of show:

Lisa Zhang
What a fantastic quarter! Sharing a few highlights:

To manage a team, keep your workspace organized, and chat with your mates in one place, turn to Slack.

Slack vs Discord

Battle of the chat apps—which should you use?

COMMUNICATION IS KEY. Yes, that's an old saying, but it's something that is especially true in the modern digital age, where we stay in touch with friends, work colleagues, even family. In order to build strong communications, you need an equally strong application to make things as simple and clear as possible. That's where these two apps come in.

Whether you're after a corporate or more gamer-focused app, Slack and Discord are two of the most prominent connectivity platforms to choose from. Both essentially offer the same service, but with unique features that set them apart, it's often difficult to decide which one to primarily use. Let's pit them against each other and figure out which one will be victorious.

In the grand scheme of things, both apps are fairly new to the party, with the oldest, Slack, releasing in August 2013, while Discord came out in May 2015. Yet despite being relatively young, they have made quite an impact, with millions of active worldwide users.

Slack was created by founder Stewart Butterfield, who knows a thing or two about software services as he one of the co-founders of photo sharing site Flickr. Butterfield and his team accidentally kick-started Slack by starting to develop something for the massively multiplayer online role playing game market. In 2009, they created a gaming developer called Tiny Speck, working on the MMORPG Glitch. It was a unique title as it didn't have combat mechanics, and was based on a 2D platform design with surrealist and fantasy-esque aesthetics. It was popular with a loyal but sadly small audience.

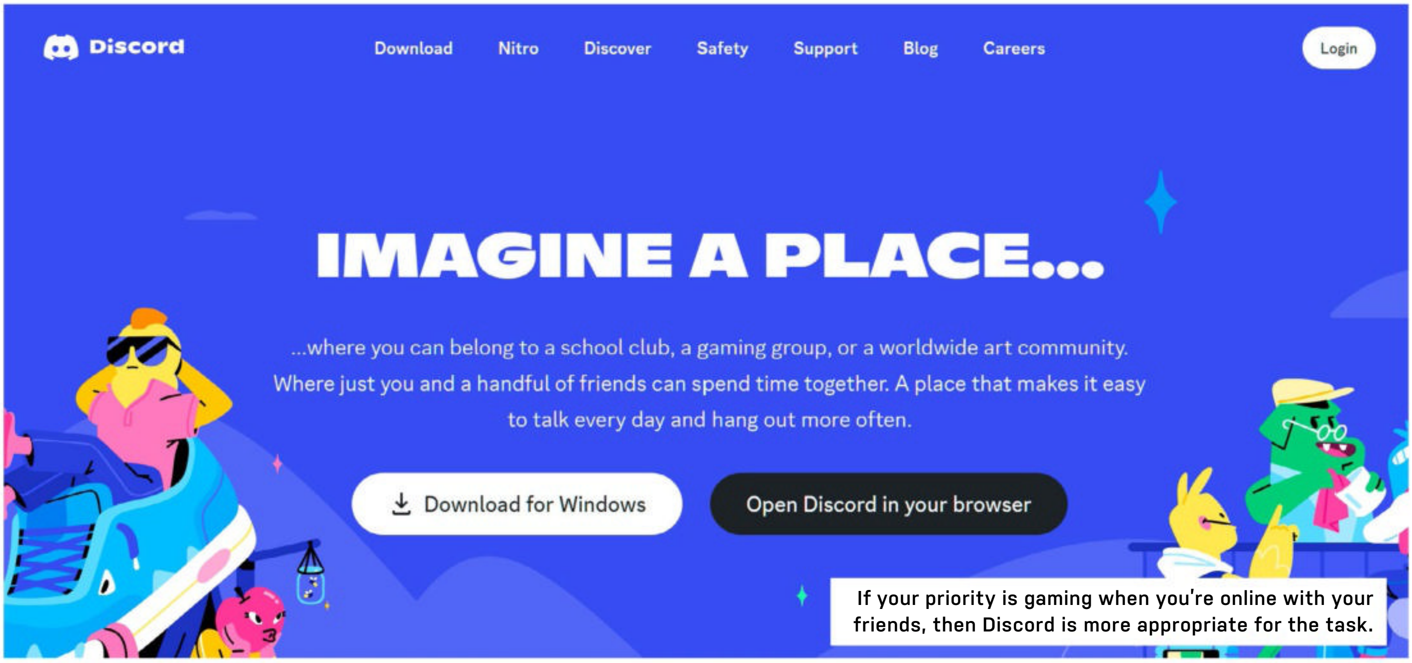
During its development, the team had to think of a way to improve communication, as they were spread across Vancouver, New York, and San Francisco, despite only being a tiny team of four. To overcome working across different time zones, they used an application that was popular during the late '80s and '90s, Internet Relay Chat (IRC). It was okay, but Butterfield knew they needed a more reliable way to communicate, so they started creating their own in-house tool.

By 2012, Glitch had a slim limelight, and unfortunately wasn't sustainable due to a lack of audience. This prompted the team to focus more on its own communication tool, which was slowly being developed over time. One issue with IRC was it wasn't asynchronous. This is something that had to change with what would become Slack. It meant that messages would be waiting for you once you logged in. The two other features that are still prevalent in Slack are centralization and transparency. Instead of using a multitude of applications, you can share files, email, meet, and keep everything organized. Slack's design language is what makes it so successful within businesses—it keeps a clean UI with plenty of colors to help organize things.

With somewhat similar humble gaming beginnings, we welcome Discord to the server. It started to solve one major issue at the time within the PC gaming sphere, communicating with friends. Founders Jason Citron and Stan Vishnevskiy, both die-hard gamers, were very fond of the connections and friendships developed over the years through their passion for gaming. Although other systems were in place to communicate online at the time, they knew they needed to create a more reliable, quicker, and easier-to-use tool in order to achieve a more seamless gaming party experience. This in turn should create stronger bonds between gamers and improve their experiences.

It wasn't until 2015 when Discord—what Jason and Stan had envisioned all of this time—came to fruition, and was shown to the world. It offered a system in which you can easily talk to your friends, stay in touch with shared interests and communities, text, voice call, and video call over the internet. The aim was to create a hub where people can join, connect, and enjoy this system, and that was well and truly achieved from the get-go.

© SLACK



IMAGINE A PLACE...

...where you can belong to a school club, a gaming group, or a worldwide art community. Where just you and a handful of friends can spend time together. A place that makes it easy to talk every day and hang out more often.

If your priority is gaming when you're online with your friends, then Discord is more appropriate for the task.

© DISCORD

HEAD TO HEAD

Fundamentally, both apps offer very similar features. Although both have fantastic, visually appealing user interfaces that provide a playful yet practical layout, Slack favors the more professional approach, while Discord has gaming at the forefront. So depending on what angle you're coming from, this might be your deciding factor. In terms of design, Slack was a slightly better experience. It has a more vibrant color scheme which makes the interface easier, more efficient, and even quite fun. We preferred Slack's default lighter theme to Discord's default darker theme, though both can be changed if necessary.

Discord just looks noisier to us. The layout, however, was relatively similar. To the left of both landing pages are sidebars featuring icons of people you connect with via direct messages, channels, threads/servers, etc. The main section was the chat part of these elements, just expanded, with search bars at the top.

Let's turn our attention back to the features, which is where things start to take a turn. Both applications offer free and paid tiers, but Discord offers more value for its free membership. Most of Discord's features are available for free, while the same can't be said for Slack. Discord does support data retention, but Slack only supports it for 90 days with its free version, which is frustrating if you want to look through your chats. Also behind a paywall on Slack are certain voice call features, such as calling with more than one other participant, which again, causes frustration, as this is supposed to be a place for centralization. If you want this, it'll cost a minimum of $7.25 (technically $3.62 for the first three months due to a discount).

Where Slack takes the upper hand again is productivity. It features elements called channels, where your work within a team happens, and can help keep track of your team and current projects. Shared channels can also be created to include members from external sources too.

Discord also features channels, but these work in a slightly different way. Communities are split up into servers. Within these, you have text and voice channels. The latter gives you options to connect via voice or video and to go live by sharing your screen (streaming). In the text channels, you can post messages, images, files, etc. Both Slack and Discord have direct messaging features with the same functionalities—these are snappy, easy to use, and work effectively. Slack's system is more intuitive than Discord's, and has a more business-led projection.

Your preference will depend on whether you want business or pleasure. If you are here for the prior then go with Slack—for pleasure, go with Discord.

Some areas where Slack tops Discord are file sharing, app integrations, text communication, and the interface. You can simply share larger files, as Google Drive is integrated. Other integrations include Zoom, Google Calendar, Google Sheets, Dropbox, OneDrive and SharePoint, Salesforce, and more.

In contrast, Discord beats Slack when it comes to audio and video calls. With an 8MB file sharing limit, compared to Slack's 1GB per file with its free package, it's not going to beat Slack in productivity, but for gaming, it's the winner. It's mainly the ease of use and being able to quickly change input and output settings that make Discord a better system for calling.

However, if you have to choose one, Slack is a more well-rounded product, with a cleaner UI and better organization so you can keep tabs on all of your workflow. It also still offers the ability to voice call. It's a very handy tool that we recommend you to keep, and despite needing the Pro package to get all of the necessary features from it, it's actually worth the monthly installments to keep your productivity and communication running smoothly. **–SAM LEWIS**

VERDICT 9

Slack

➕ **NOT SLACKING** Organized UI; Bold and color ordered; The one app that does it all.

➖ **SLACKER** Basic features such as group calls are behind paywalls.

Slack Free $0.00, Slack Pro $7.25/month, Slack Business+ $12.50/month, www.slack.com

VERDICT 8

Discord

➕ **GAMING PARADISE** Fun, quirky design; The best gaming party chat application.

➖ **DISCORDED** Noisier layout; Less productivity-based features.

Discord Free $0.00, Discord Nitro Basic $2.99/month, Discord Nitro Basic $9.99/month, www.discord.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> 7600X Motherboards
> Blueprint Ideas
> Water Cooling Difficulties

Motherboard Meeting

I'm planning on buying an AMD Ryzen 5 7600X because of its excellent price-to-performance ratio. It's faster out of the box than most AMD 7000 chips. Which motherboard do you recommend in the B650 class? I'm not a gamer, but I do like photography. I will likely use the on-board video port. I want a PCIe 5.0 slot in case I need it down the road. The GIGABYTE B650 AORUS Elite AX is the mobo I have in mind, which has 2.5G ethernet, PCIe 5.0, and HDMI.

I'm sad there will be no more tactile version of *Maximum PC*, but will always be a subscriber. Thanks for your help on this issue. **–S. Sherk**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: I've used the Gigabyte Z790 GAMING X AX on a personal build, and have nothing but good things to say about it. It's a different chipset to the one you're looking at, as it's for Intel CPUs, but your suggested Aorus should do you well.

The other option is to look at the one Sam recommends in his in his mid-range Blueprint (page 97), which is the ASRock B650M PG RIPTIDE WIFI Micro ATX AM5. Yes, it's a Micro ATX form factor, so may not be totally suited to your needs, but it's a good board at a great price. Good luck on the build!

Entry Level vs Mid Range

I like your magazine a lot. Even though I'm not skilled enough to build my own PC, I've learned a lot about computers, and I'm able to pick out components for a custom build. Your work is appreciated.

It's sad that the physical magazine is gone, but you guys do a good job on the digital format and make it look like the physical magazine, so it's okay.

Your gaming builds have changed quite a bit lately, but I did read your rationale for that. However, I think you need to have these three builds:

Entry-level gaming system (for 1080p, no lower than an RTX 3060 or RX 6600, roughly $1k).

Mid-range (for 1440p, no lower than an RTX 3070 or RX 6800, roughly $1.5k).

Premium-range gaming system (go nuts).

For those who are looking for an entry-range non-gaming system for under $600, you can remove the graphics card from the entry-level system and select a few cheaper parts, such as a slower CPU or cheaper motherboard. This could be a bonus 4th blueprint.

If you water down the entry system too much, it becomes a bad blueprint for someone who wants a good gaming system that will be able to play the latest games for the next 2-3 years. **–S. Philips**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks for your feedback. We've settled on what you suggested pretty much in terms of how the categories are defined, and been clear in these pages about taking out the GPU from the budget build if it's not needed.

The next few months should be interesting in terms of updating these builds. First of all, we have new GPUs on the way in the form of the RTX 4060, and hopefully something cheaper from Team Red. Also, GPU prices in general are falling, which is a good thing, as sky-high prices have stopped many people upgrading to this generation of cards. Hopefully our writer, Sam, can spec out some even better entry-level and mid-range builds soon.

Carnival Computer

I am so glad that you have taken the magazine digital. I've had my subscription to *Maximum PC* in digital format for several years now, and look forward to additional developments.

I have used your magazine to help me build each of my new computers over the years. I've attached an image of my new liquid-cooled beauty influenced by articles and ads. I love to walk by my office and see the carnival.

One thing that no one really talks about in any article is how hard it is to measure and bend the tubing. Corsair sells a "kit" that is useless except for the silicon guide.

I had to build my own jig and figure it out myself. Since the bending process was so intense, I gave up

↘ submit your questions to: editor@maximumpc.com trying to bend tubing for the graphics card and the M.2 drives and settled for the colorful CPU, but it is gratifying to see the light show and my friends' faces the first time they see it. Also, it was difficult to find white components. I had to resort to painting the Corsair power supply.

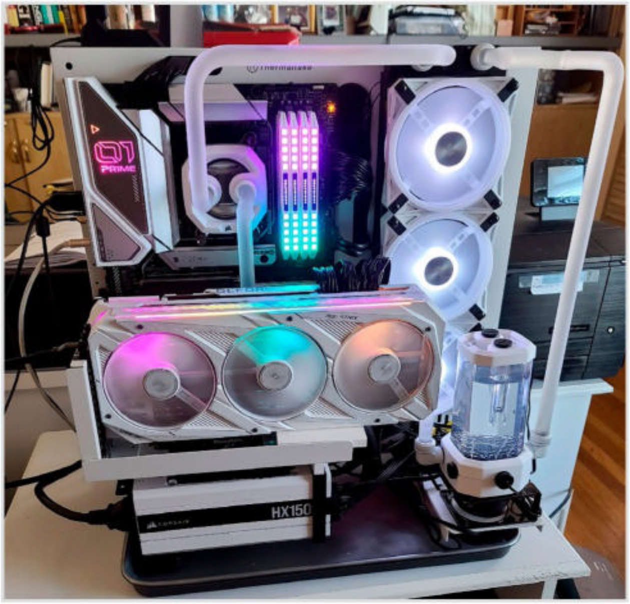
This will probably be the last computer I will build, since I'm now 76 years old and my builds usually last for 6-10 years. **–D. Meister**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks for sharing your build. We actually built a watercooled PC using a similar Corsair kit in our June 2022 issue, and I thought it made the process of bending tubes and making custom loops easier. However, it's still a tricky process for first-timers, which is why we plan on doing an updated version soon. Stay tuned!

Digital Divide

Hello, first of all I want to congratulate you for such an excellent magazine, I've been a subscriber for almost 10 years, and it's my favorite magazine. I got to know *Maximum PC* through Zinio, and from the beginning I liked that it was completely digital, since I received it faster and cheaper. However, now that the physical edition is no more, I realize that now there is going to be a lot more content, in addition to an archive of the last 12 years, which is very good for nostalgia. The audio content is phenomenal—hearing your voices gives it a much more human touch that is not possible with just text. So thank you very much and keep up the good work! **–E. Villarreal**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks for the feedback—Sam and I enjoy doing the new audio feature talking through the cover build each issue. But in the interest of balance...



We like the look of this rather psychedelic construction.

The Adjustment Bureau

Honestly, I prefer print, but I'll stick with you for now. If *PC Gamer* or *Retro Gamer* did this, I would drop the subscription. I bought a $230 tablet to read the magazine—we will see if I make the adjustment. **–A. Friedrich**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you to those who contacted me to offer constructive criticism and feedback, and who have given us a chance with the digital edition. Speaking of which...

Print Preference

I've been reading your magazine on my iPad since April 2012, so the move to digital makes no difference to me. If it means more content, all the better!

Just do me a favor and keep the "magazine" style layout—don't go down the path other PC titles have, which spread about one tenth the content in large text on scrolling pages. **–D. Stacey**

Zoom Happy

Thank you for the digital version of *Maximum PC*. I'm an elderly gentleman (80 years), and find the digital edition very helpful to be able to resize the pages. I have to use a magnifying glass sometimes with the magazine. I look forward to the new edition every month. **–L. Murray**

Industry Malaise

I've subscribed to *Maximum PC* from the very start. I've enjoyed reading your articles and guides for all these years. While I recognize the forces driving you to digital-only, I wish it didn't have to happen. I read all my books with an eReader these days, but I still enjoy being able to sit with a magazine in hand in a comfortable chair.

Maximum PC today is not as compelling as the early years of *Maximum PC*, but not because the quality of your articles has diminished. Rather, the computer industry has progressed so far that new developments are not as exciting. In the early years, PCs were changing dramatically month to month. Each new CPU, GPU, or other hardware release brought significant improvement to the experience. Computers have gotten so good that the advances are almost insignificant. A 10 or 15 percent performance increase doesn't matter when the old hardware is already so good.

Still, it's great fun reading about the industry and where it's heading. I shall remain a loyal reader. **–F. Fuller**

Searchable Archive

After reading your "Digital Natives" intro in the May 2023 edition, I was wondering if the subscription archive is or will be searchable? I usually have to thumb through the old hard copies to find articles I recall reading, but can't recall the issue it was in. **–S. Morman**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you for your feedback. Obviously, some were unhappy about our move to digital, which was a reminder of how deeply passionate many people are about this title and its rich history. While I know many of you may miss the print edition, it was encouraging to see how many were excited about the move and the new features we can offer. In case you missed it, we now include a discussion of our cover builds each issue, which is now an interactive feature embedded on page 16.

I encourage you to continue sending in your feedback and suggestions. We don't have a searchable archive just yet, but I've brought this up with our digital team as something we'd like to do. Obviously, we're dependant on our digital partners, but we'll do everything we can. Email me on the usual address, and I'll feature the best ideas in an upcoming issue.

THE BUILDS

THIS MONTH'S STREET PRICES...

IN THE LAST ISSUE, we made quite a few changes on our Intel budget build by including parts we used in that issue's main feature machine. The biggest of them all was the GPU—no shock there! We swayed across from team Nvidia and hopped onto the new Intel GPU train with the A750. For 1080p gaming, we were more than satisfied with our results. Additionally, you can pick these up for $250. That's not a bad little package, is it?

So we kept this GPU in place, along with our newly added Intel Core i3-13100F for this issue. This is $10 cheaper than last time thanks to a nice little discount. As for the rest of the Intel budget machine components, nothing changed other than our motherboard, the ASRock B660M-HDV Micro ATX. This went from $85 to $94, and at $95, the Pro RS B660M Micro ATX board from ASRock is a better choice, with two more DIMM slots for a larger maximum memory capacity. With some minor price fluctuations, our build went down from $771 to $766—not much, but any savings are a bonus!

As for our AMD machine, we swapped out the MSI MECH 2X OC Radeon RX 6500 XT, as this saw a price increase of $25 from $165 to $190. We found an ASRock Phantom Gaming D OC 6500XT for $165 over on www.newegg.com, so opted for that to keep the original price the same. Thankfully, we didn't need to change our AMD Ryzen 5 5600 that we added last time—in fact, this actually lowered in price from $160 to $137. Nothing else changed other than the $10 saving on the RAM, so we kept everything else the same as last month. This brought our overall price for the AMD budget machine to $732 (previously $765). Saving money on both machines, while not massive, is a move in the right direction. Thankfully things seem to be calming down after the pandemic pandemonium, which is what we like to see.

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W Corsair CV450 80+ Bronze	$59
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard	$119
CPU	AMD Ryzen 5 5600	$137
GPU	ASRock Phantom Gaming D OC Radeon RX 6500 XT 4GB **NEW**	$165
RAM	16GB (2x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3200MHz	$45
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$30
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$732**

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W Corsair CV450 80+ Bronze	$59
Mobo	ASRock B660M Pro RS Micro ATX LGA1700 **NEW**	$95
CPU	Intel Core i3-13100F	$110
GPU	Intel Limited Edition Arc A750 8GB	$250
RAM	16GB (2x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3200MHz	$45
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$30
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$766**

MID-RANGE

MOVING ON FROM our budget builds, we take a step up in performance thanks to an extended pot of virtual dollars with our mid-range machines. With these PCs, we're sneaking into the QHD territory of gaming, which for us, is the happy medium. We're also paying more attention to the prices of our builds as of late—although the overall cost of these machines isn't as vital as it is for the budget systems, we're still making a conscious effort to make a great bang for your buck PC.

From the Ryzen 5 5600 budget AMD processor, we kick things up a notch up to the Ryzen 5 7600, which luckily is $10 cheaper than last time. This six-core processor with a max boost clock of 5.1 GHz is still being paired along with a Radeon 6750XT GPU, specifically the Gigabyte Gaming OC model. Again, like the CPU, the GPU has a $10 reduction. Another welcome saving came with our Crucial P5 Plus 1TB SSD, as that dropped from $90 to a much sweeter $70. Thank you very much, Crucial!

With those savings, we decided to give our motherboard not only an upgrade in form factor and memory capacity, but also a better chipset. We've ditched the B650M for a B650E with the ASRock B650E PG RIPTIDE WIFI board. At $215, it's a future-proofed mobo, and a big upgrade over the previous ASRock B650M PG RIPTIDE Wi-Fi Micro. Aside from the motherboard change, we left things as they were, and this resulted in a new price of $1,392 from $1,412.

Over on the Intel mid-range machine, we ended up keeping the same lineup after recently adding a few new arrivals to the mix, including the CPU and GPU last issue. Across the board, we were happy to see yet more price reductions, including savings on our CPU, GPU, RAM, CPU cooler, and SSD. This saved us a total of $46, which could easily be spent on doubling the secondary hard drive storage if you need it.

AMD INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$130
PSU	750W EVGA 750 BP 80+ Bronze	$90
Mobo	ASRock B650M PG RIPTIDE Wi-Fi Micro ATX AM5 **NEW**	$215
CPU	AMD Ryzen 5 7600	$220
Cooler	Cooler Master MASTERLIQUID ML240L RGB V2	$90
GPU	Gigabyte Radeon RX 6750 XT Gaming OC 12GB	$390
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$105
SSD	1TB Crucial P5 Plus NVME M.2 PCIe 4.0	$70
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,392**

INTEL INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$130
PSU	750W EVGA 750 BP 80+ Bronze	$90
Mobo	Gigabyte Z790 UD AC ATX LGA 1700	$195
CPU	Intel Core i5-12600KF	$220
Cooler	Cooler Master MASTERLIQUID ML240L RGB V2	$92
GPU	Gigabyte GeForce RTX 3060 Ti EAGLE OC 8GB	$410
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$105
SSD	1TB Corsair MP600 PRO NH M.2 PCIe 4.0	$75
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,399**

TURBO

AMPING EVERYTHING up to the max are our Turbo builds. As the name implies, they are mighty fast, and if they go wrong, they will take you on a first-class trip to financial ruin. Even so, we live for these machines. These PCs are designed to give you the best "money-no-object" experience—if we can save some money then we will, but you get the idea.

In our main build, we got our hands on the range-topping AMD Ryzen 9 7950X3D processor. This was very impressive, although against the Intel Core i9-13900K, it was slightly behind on our benchmarking results. It was also around $80 more expensive, but one heck of a powerhouse, which is why we are introducing it to the AMD Turbo. To cool this, we've also included the NZXT Kraken X73 360MM AIO from that build. It kept our CPU running smoothly, and the infinity display is a nice aesthetic touch.

Giving us the most grunt is once again the ASRock Phantom Gaming OC Radeon RX 7900 XTX. It's a 24GB pre-overclocked graphics card, and (at the time of writing) still the top-performing model in AMD's GPU lineup. At under $1,000, it's cheaper than Nvidia's top card, the RTX 4090. Just like the GPU, we didn't alter the rest of the build—the only thing that really changed was the price, from $2,666 to $2,951.

We haven't changed the Intel hot seat—the faithful Core i9-13900K remains. Next to that is our 64GB Corsair Vengeance DDR5 RAM that runs at 5200MHz. This is also in the AMD turbo build, and saw a reduction of $35. We've stuck with the Western Digital 1TB SN850X as our primary drive, and 6 TB of Western Digital Blue as our secondary storage. The GPU also remained, as it's one of the least expensive RTX 4090s at under $1,600.

Our only change was our NZXT C1000 PSU to Corsair's RM1000x 80+ Gold due to needing an extra PCIe port. We had this problem with the NZXT PSU in this issue's build on page 16. Our RTX 4090 needed four individual PCIe cables, and we could only use three, which slightly restricted the GPU's power! Woes aside, the Intel Turbo build was cheaper than previously, with a saving of $24, bringing it down to $3,365.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	1000W NZXT C1000 80+ Gold	$180
Mobo	ASRock X670E PG Lightning ATX AM5	$260
CPU	AMD Ryzen 9 7950X3D **NEW**	$700
Cooler	NZXT Kraken X73 RGB 360mm **NEW**	$225
GPU	ASRock Phantom Gaming OC Radeon RX 7900 XTX 24GB	$999
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$180
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$85
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,951**

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	00W Corsair RM1000x 80+ Gold **NEW**	$189
Mobo	Gigabyte Z790 UD AC ATX LGA 1700	$195
CPU	Intel Core i9-13900K	$570
Cooler	NZXT Kraken X73 73.11 CFM 360mm	$225
GPU	Zotac GeForce RTX 4090 GAMING Trinity OC 24GB	$1,599
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$180
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$85
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$3,365**

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